The Capability Maturity Model for Software: An Overview

Objectives:

- **Examine the SEI's Capability Maturity Model for Software**
- **Identify the basic purposes of each Maturity Level**

The Problem:
too many immature software organizations

Good performance is possible - but

- **Requirements often misunderstood, uncontrolled**
- **Schedules and budgets frequently missed**
- **Progress not measured**
- **Product content not tracked or controlled**
- **Engineering activities nonstandard, inconsistent**
- **Teams not coordinated, not trained**
- **Defects proliferate**
- **Success depends on “heroes”**

“Schedules run everything”

“Just send in the Tiger Team”

“Processes limit my creativity”

“Processes don’t help my delivery schedule”

Capability Maturity Model Overview

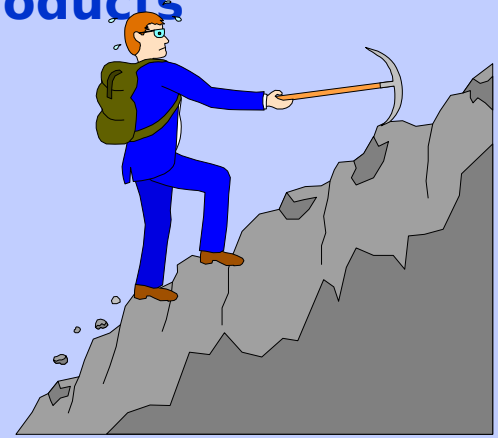
- Developed at the DoD-sponsored Software Engineering Institute (SEI)
- Focuses on practices that are under control of the software group
- Describes common sense, efficient, proven ways of doing business (which you should already be doing) - not a radical new approach
- Presents a minimum set of recommended practices that have been shown to enhance a software development and maintenance capability
  - It defines the expectation (the “what”)
  - Without overly constraining the implementation (the “how”)
- Used by Government and industry around the world to measure maturity of software development organizations
- Being updated in the SEI’s CMM Integration (CMMI) effort

Objectives of the CMM

To increase customer satisfaction, **by producing products according to plan while simultaneously improving the organization's capability to produce better products**

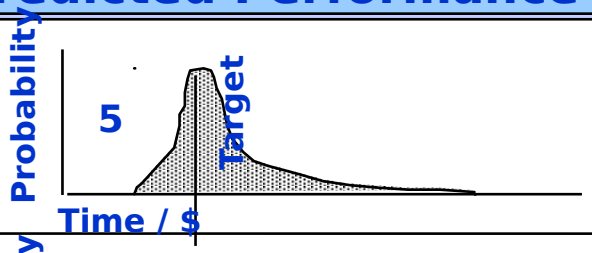
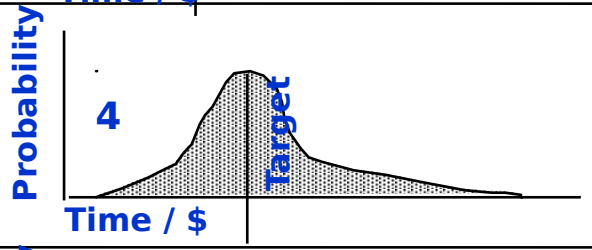
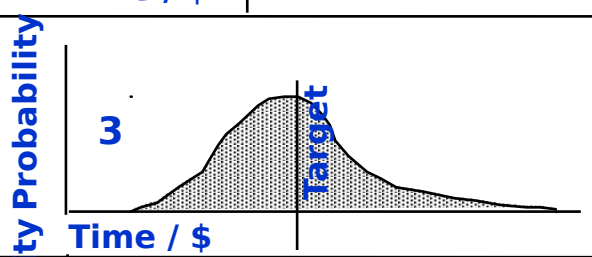
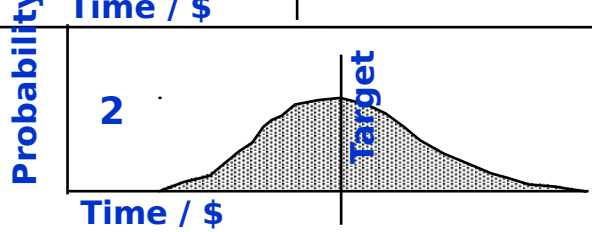
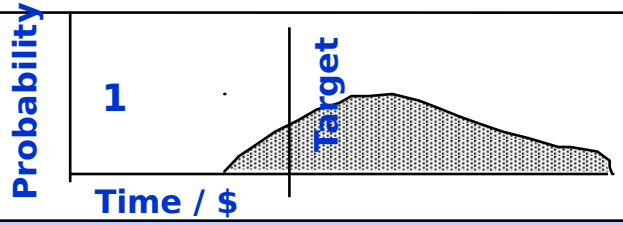
To increase software process maturity, **the extent to which processes are explicitly defined, managed, measured, controlled, and effective, by:**

- **Establishing basic project management controls**
- **Standardizing the organization's software process activities**
- **Quantitatively analyzing processes and products for monitoring and control**
- **Institutionalizing process improvement**

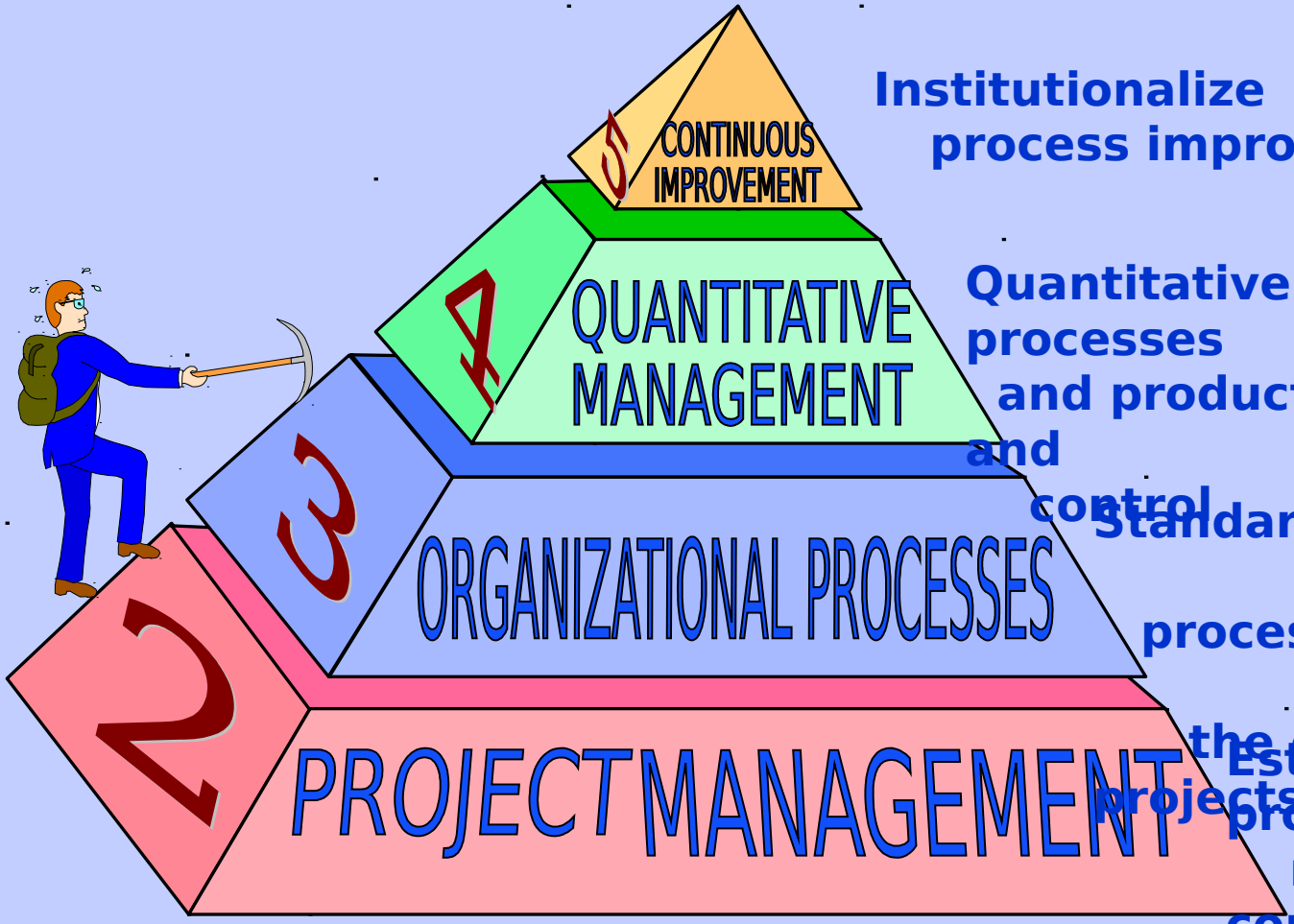


The CMM's Five Maturity Levels

Process Maturity Benefits

Level	Process Characteristics	Predicted Performance
5 Optimizing	Process improvement is institutionalized	
4 Managed	Product and process are quantitatively controlled	
3 Defined	Software engineering and management processes defined and integrated	
2 Repeatable	Project management System in place; performance is repeatable	
1 Initial	Process is informal and ad-hoc; performance is unpredictable	

CMM Building Blocks: the Maturity Levels



Institutionalize process improvement

Quantitative analysis of processes and products for monitoring and control

Standardize the software process activities for all the organization's projects

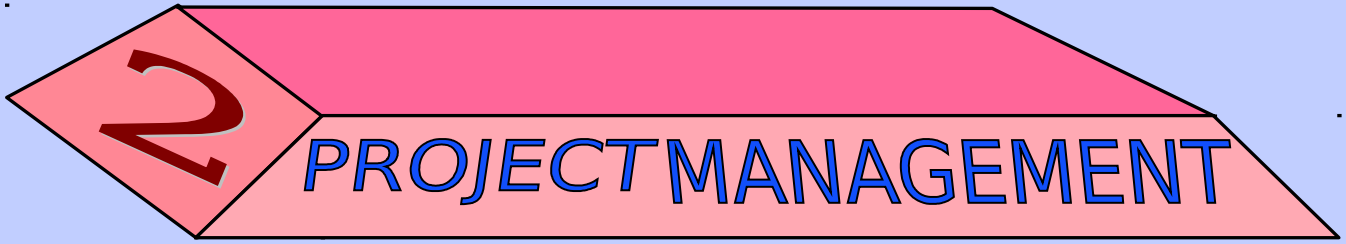
Establish basic project management controls

Project Management Risks Addressed by CMM Level 2

Risks	Issue
• Little agreement on technical requirements	Requirements
• Weak control over changes to requirements	
• Weak understanding of activities, effort, and time required	Plans
• Sketchy plans, schedules, budgets	
• Program risks not identified or managed	
• Weak visibility into actual progress	Progress
• No ability to take corrective action	
• Little visibility into quality of products and processes	
• Weak control over contents and changes to products	Control
• Contractors not qualified to perform the work	
• Weak control over contractor activities and products	

CMM Level 2: the "Repeatable" Level - Establishing basic project management controls

- **Builds a "foundation" for Process Improvement**
- **Actions:**
  - **CLARIFY REQUIREMENTS**
  - **DOCUMENT PLANS**
  - **TRACK PROGRESS**
  - **CONTROL PRODUCTS**



What to Do at Level 2

CLARIFY REQUIREMENTS
- Baseline the requirements allocated to software

DOCUMENT PLANS
- Estimate the project's size, effort, costs, and resources
- Establish the project plans and processes; identify risks

TRACK PROGRESS
- Measure actual progress to enable timely corrective action
- Verify adherence of products and activities to requirements

CONTROL PRODUCTS
- Identify and control software products, changes, problem reports
- Select qualified subcontractors; manage their activities

Key Process Area

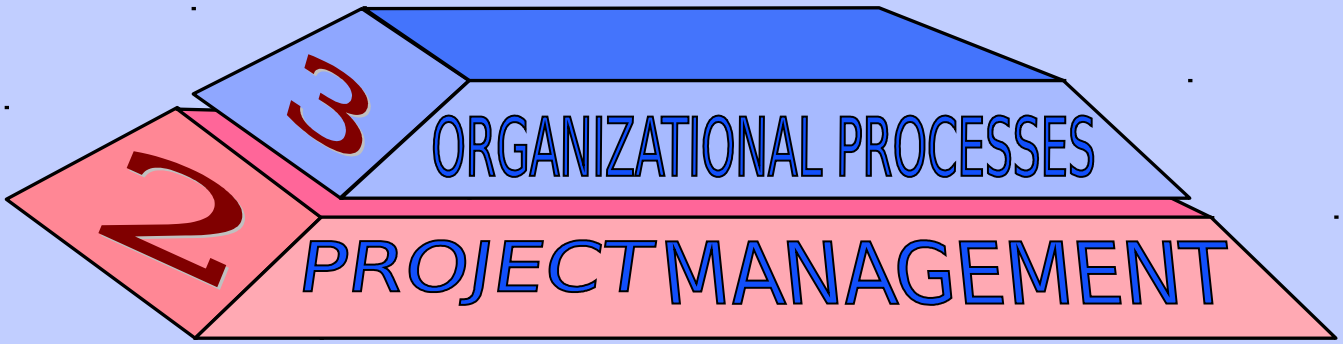
- ***Requirements Management (RM)***
- ***Software Project Planning (SPP)***
- ***Software Project Tracking and Oversight (SPTO)***
- ***Software Quality Assurance (SQA)***
- ***Software Configuration Management (SCM)***
- ***Software Subcontractor Management (SSM)***

Organizational Process Risks Addressed by CMM Level 3

Risks	Issue
• No centralized coordination of the way we produce software	Processes
• No central source / repository of processes, templates, samples, lessons learned, project data	
• Engineering activities unplanned, uncoordinated, inconsistent among projects	
• Management activities not coordinated with technical activities	
• Engineering groups not coordinated, little understanding of roles or commitments	Teamwork
• Team members unprepared for their jobs	
• Defects proliferate in products	Defects

CMM Level 3: the "Defined" Level - Standardizing the Organization's software process activities

- Focus changes from the project level to the organization level
- Capabilities are based on practices established in Level 2
- Emphasis is on developing software across the organization
- Actions:
  - STANDARDIZE PROCESSES
  - CULTIVATE TEAMWORK
  - REDUCE DEFECTS



What you see at Level 3

STANDARDIZE PROCESSES
- Establish organizational responsibility for SPI
- Define the organization's best practices; establish asset database
- Tailor the organization's best practices to projects
- Establish standards for software engineering activities

CULTIVATE TEAMWORK
- Get agreement from all parties on requirements and commitments
- Develop the skills and knowledge of team members

REDUCE DEFECTS
- Identify and remove defects early and efficiently

Key Process Areas

- *Organizational Process Focus (OPF)*
- *Organizational Process Definition (OPD)*
- *Integrated Software Management (ISM)*
- *Software Product Engineering (SPE)*
- *Intergroup Coordination (IC)*
- *Training Program (TP)*
- *Peer Reviews (PR)*

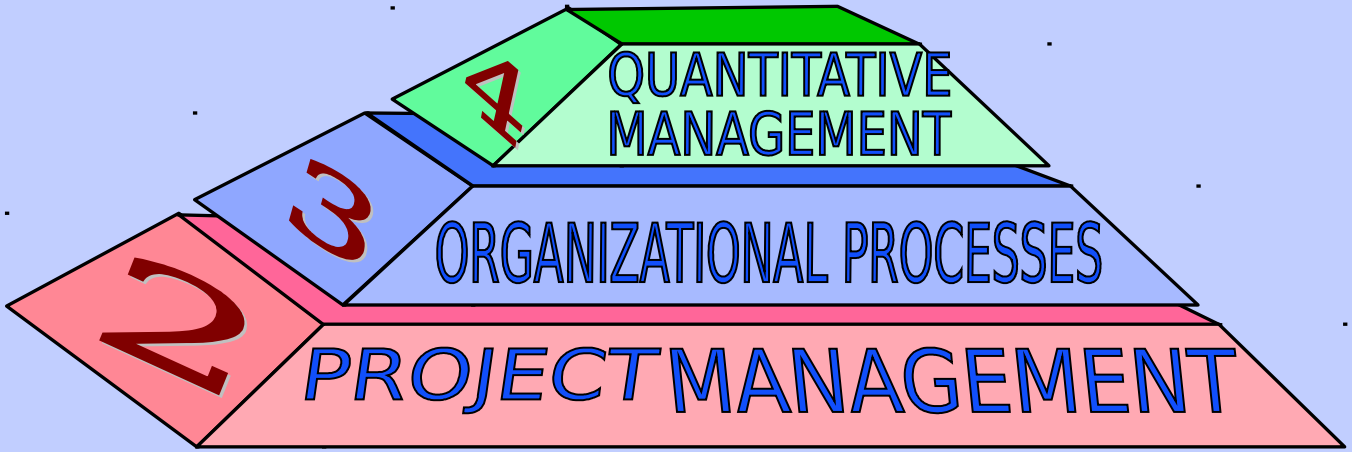
Quantitative Management Risks Addressed by CMM Level 4

Risks	Issue
• No controls or expectations of process performance	Goals
• No ability to set and achieve quality goals for products	
• Limited understanding of the performance of a project's processes	Progress
• Limited measures of the quality of software products	

CMM Level 4: the "Managed" Level - Quantitative analysis of processes and products for monitoring and control

- Measurements taken at previous levels are used to manage both products and processes

- Actions:
  - SET GOALS
  - MANAGE PROGRESS QUANTITATIVELY



A few things more at Level 4

SET GOALS

- Set numeric goals for process performance
- Set quality goals for the software products

Key Process Areas

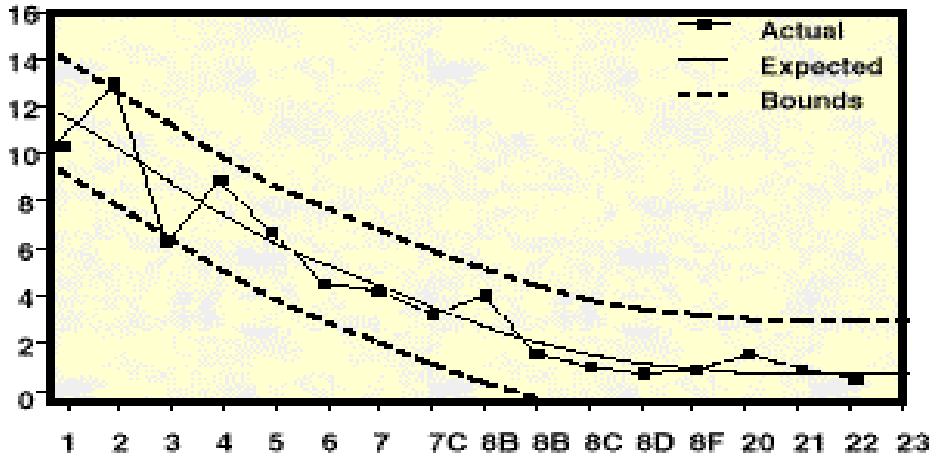
- *Quantitative Process Management (QPM)*
- *Software Quality Management (SQM)*

MANAGE PROGRESS QUANTITATIVELY

- Measure the performance of the software processes
- Measure progress toward product quality goals

Key Process Areas

- *Quantitative Process Management (QPM)*
- *Software Quality Management (SQM)*



Continuous Improvement Risks Addressed by CMM Level 5

Risks	Issue
• Defects keep recurring, causes are not known	Performance
• Process improvement activities are not uniform or fully institutionalized	
• New technologies (tools, methods, processes) are not recognized or adopted	New Technologies

CMM Level 5: the "Optimizing" Level - Institutionalizing process improvement

- The organization is focused on continuous process improvement

- Actions:
  - OPTIMIZE PERFORMANCE
  - ADAPT NEW TECHNOLOGIES

How to thrive at Level 5

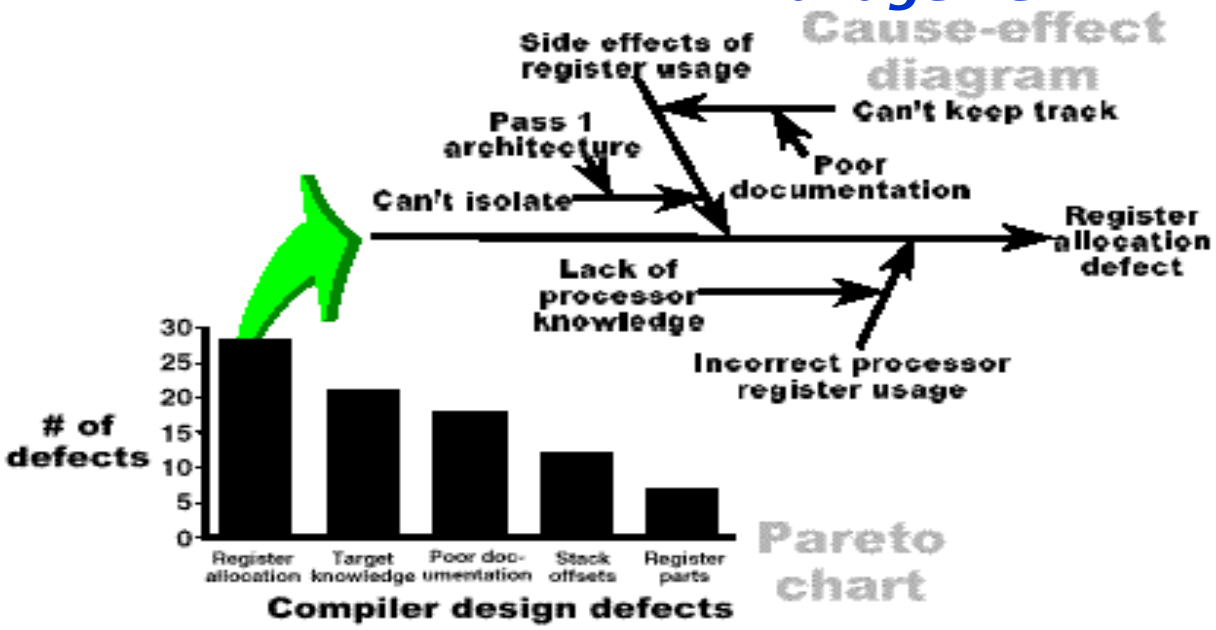
OPTIMIZE PERFORMANCE

- Identify and eliminate the cause of defects – *Defect Prevention (DP)*
- Continually improve quality, productivity, cycle times – *Process Change Management (PCM)*

ADAPT NEW TECHNOLOGIES

- Identify new technologies; transition them to use – *Technology Change Management (TCM)*

Key Process Areas

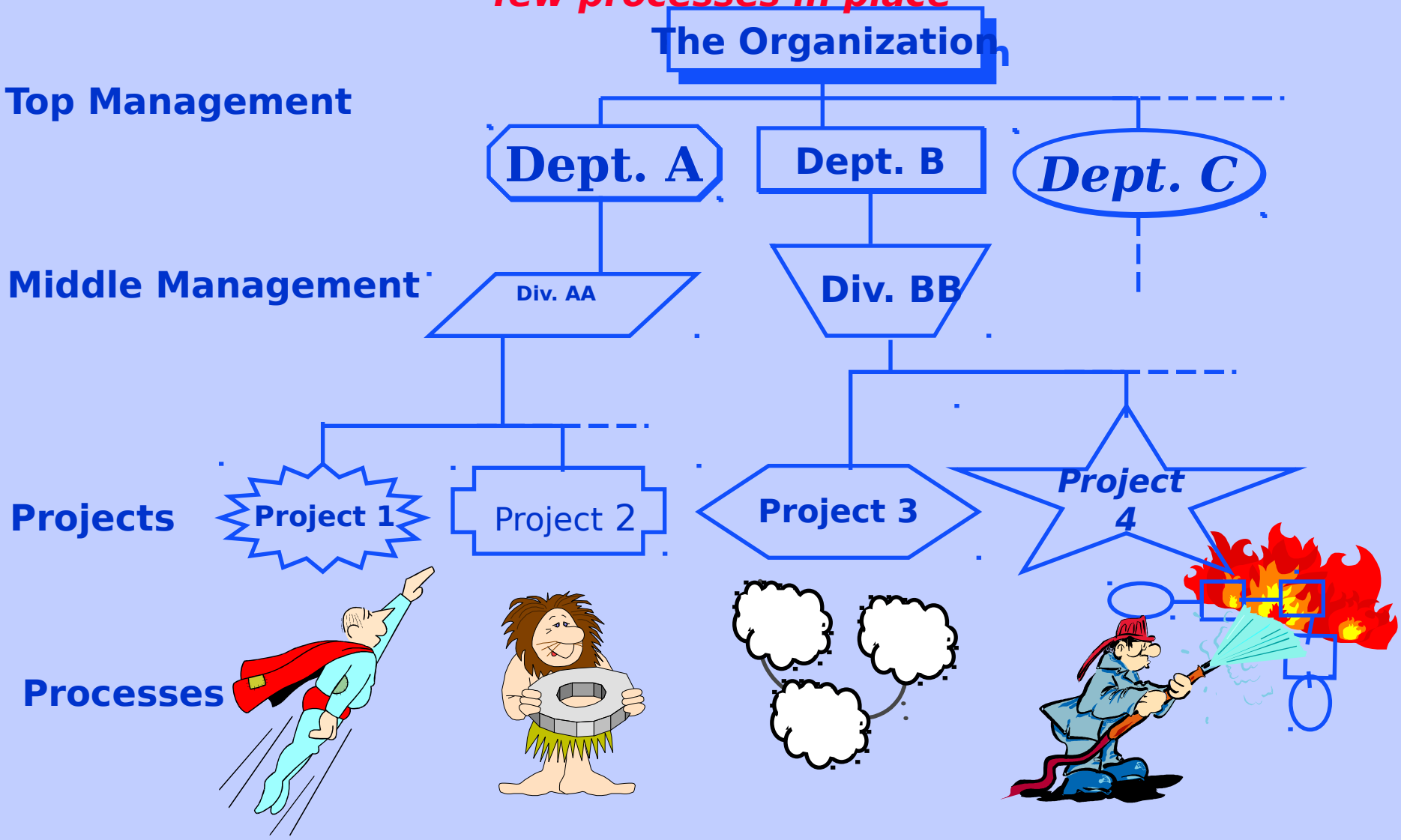


Results, Needs, and Activities the CMM Supports

Results	Needs (Actions)	Activities (steps)	KPA
Level 2: Establish basic project management processes Control products	Clarify requirements	Baseline the requirements allocated to software	RM
	Document plans	Estimate project size, effort, cost, resources	SPP
		Establish project plans, estimates, processes, risks	SP
	Track progress	Measure actual progress for timely action	SPTO
		Verify adherence of products and activities to reqts.	SQ
		Identify & control products, changes, problems	SCM
		Select qualified contractors, manage their activities	SS
Level 3: Standardize the organization's software process activities Reduce defects	Standardize processes	Establish organizational responsibility for SPI	OPF
		Define the org's best practices, set asset database	OP
		Establish standards for software engrg. activities	SP
		Tailor the org's best practices to projects	ISM
		Get agreement from all on reqts. and commitments	IC
	Cultivate teamwork	Develop skills and knowledge of team members	TP
		Identify & remove defects early and efficiently	PR
Level 4: Analyze processes & products for monitoring, control	Set goals	Set numeric goals for process performance	QPM
		Set quality goals for the software products	SQM
		Measure the performance of the software processes	QPM
	Manage progress	Measure progress toward product quality goals quantitatively	SQ
Level 5: Institutionalize process improvement	Optimize performance	Identify and eliminate the cause of defects	DP
		Continually improve quality, productivity, cycle times	PC
	Adapt new technologies	Identify new technologies, transition them to use	TC

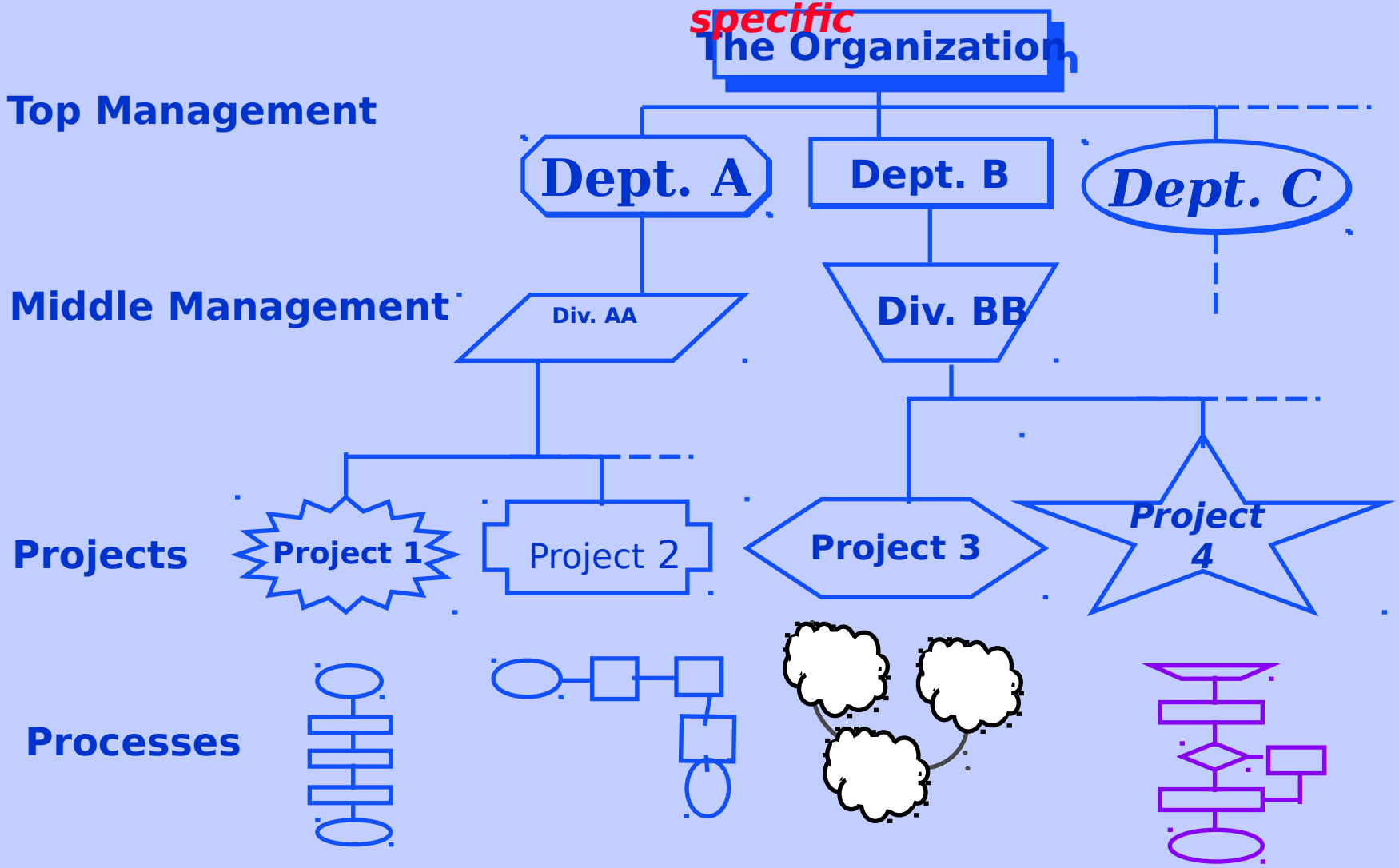
Sample Level 1 Software Organization

few processes in place



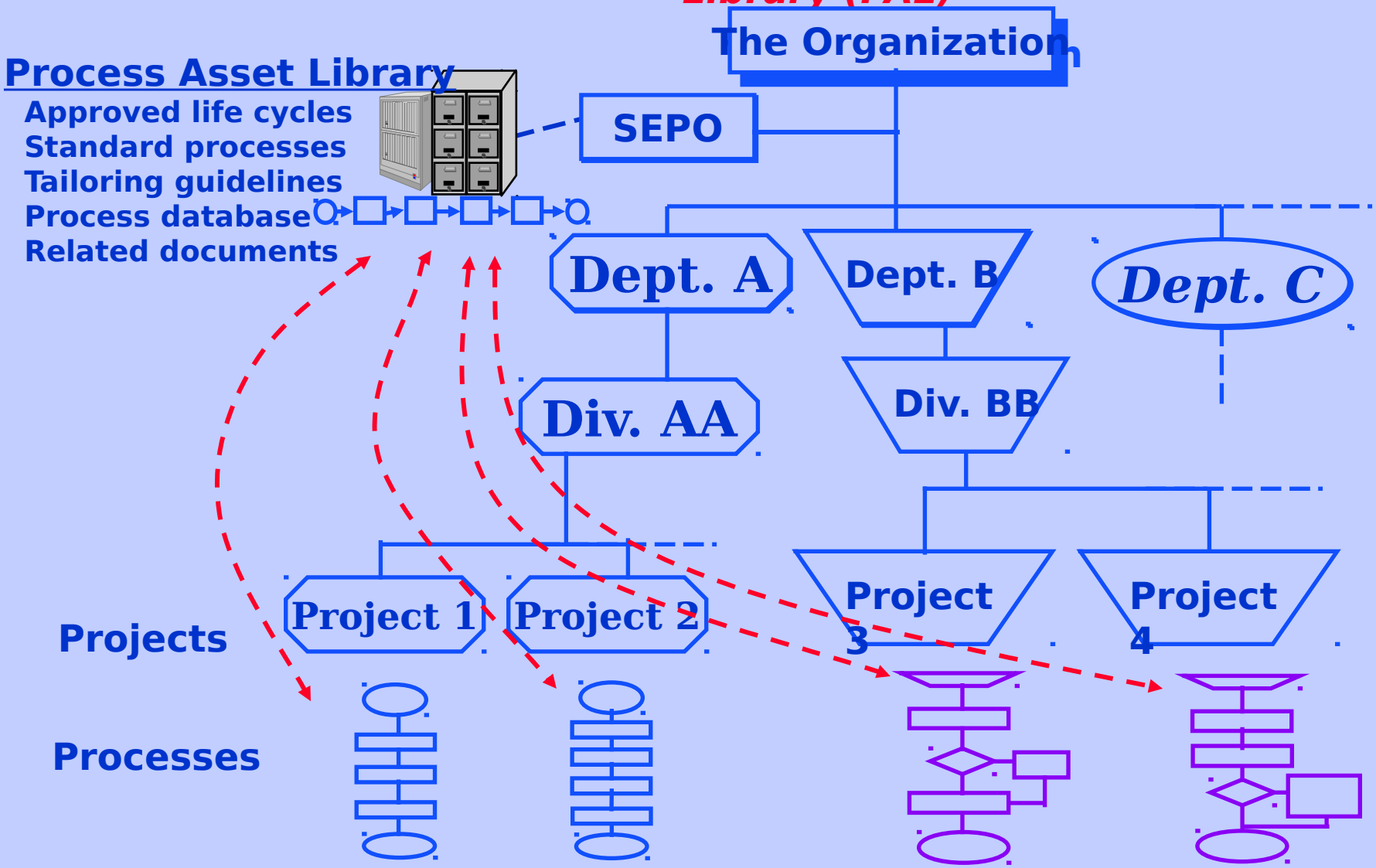
Sample Level 2 Software Organization

many processes in place; but they are project-specific



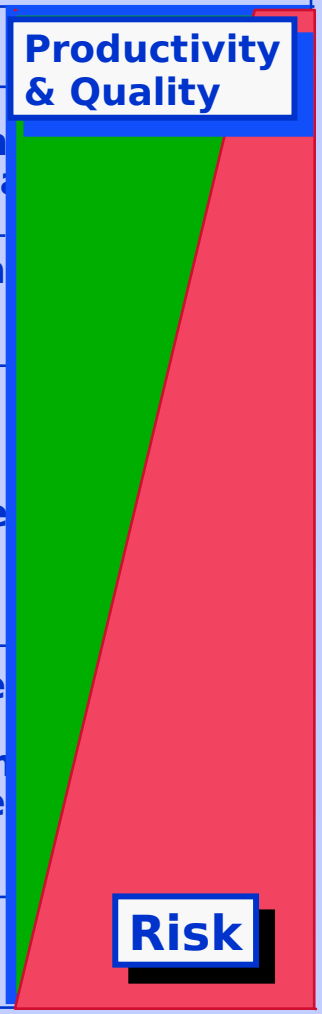
Sample Higher-Level Organization

processes based on organization's Process Asset Library (PAL)



SEI Capability Maturity Model

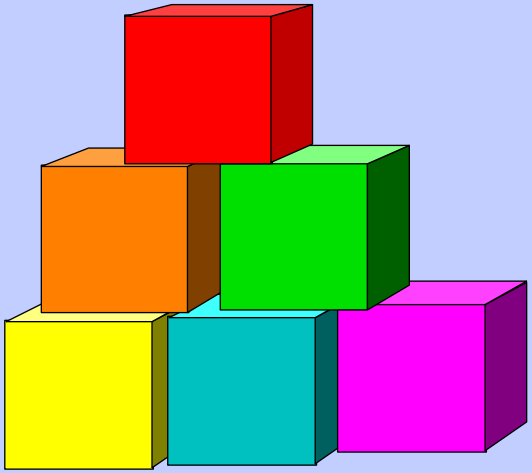
Level	Characteristic	Key Process Areas
Optimizing (5)	Continuous process capability improvement	Process change managem Technology change mana Defect prevention
Managed (4)	Product quality planning; tracking of measured software process	Software quality managem Quantitative process
Defined (3)	Software process defined and institutionalized to provide product quality control	Peer reviews Intergroup coordination Software product engineering Integrated software manageme Training program Organization process definition Organization process focus
Repeatable (2)	Management oversight and tracking project; stable planning and product baselines	Software configuration manage Software quality assurance Software subcontract managem Software project tracking & ove Software project planning Requirements management
Initial (1)	Ad hoc (success depends on heroes)	"People"



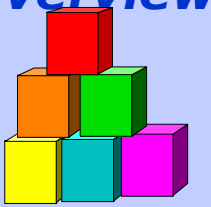
Key Process Area (KPA) Structure

Each of the 18 CMM Key Process Areas (KPAs) has

- Purpose
- Goals
- Common Features:
  - Commitment to perform: sponsorship and pol
  - Ability to perform: resources, organization, tr
  - Activities to perform
  - Measurement of performance
  - Verification of performance



Example: Structure of the Software Project Planning KPA



Purpose
- Establish reasonable plans for software engineering and managing the project

Goals
- Software estimates are documented and used
- Activities and commitments are documented
- Groups agree to their commitments

Commitments
- A project software manager is designated
- An organizational policy for planning is followed

Abilities
- Resources and funding are provided
- Training in estimating and planning is provided

Activities
- Estimate project parameters
  - size, effort, cost, schedules, risks
- Plan software activities
  - goals, life cycle, processes, standards
- Get agreements to commitments
  - from practitioners, management, others

Measurements
- Track planning status

Verifications
- Review plans with management
- Conduct independent review of planning

How is a Maturity Level determined?

The Software Capability Evaluation (SCE)

- **Description: A structured CMM-Based Appraisal in which a trained team examines an organization's current software practices. It consists of interviews, questionnaires, and analysis designed to identify the current process capability.**

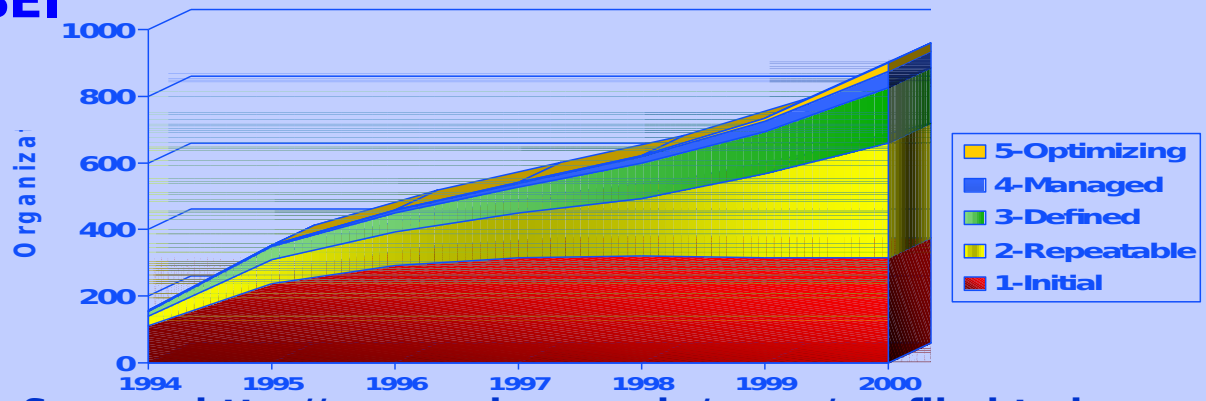
- **Evaluators: A team of 4-6 SCE-trained people, external or internal to the organization**

- **Process: Typically one week of preparation off-site, then one week of on-site interviews and analysis, using the SCE process (see guidelines on SSC San Diego PAL)**

- **Results: Comprehensive verbal and written findings of strengths, weaknesses, and areas to improve. Can optionally result in a validated maturity level.**

Process Maturity Profile of Software Community

Maturity Level	1994	1995	1996	1997	1998	1999	2000
1- Initial	71%	67%	64%	58%	52%	43%	35%
2- Repeatable	19%	20%	21%	25%	28%	34%	38%
3- Defined	10%	11%	13%	14%	17%	17%	19%
4- Managed	0%	1%	2%	2%	3%	4%	6%
5- Optimizing	1%	0%	0%	0%	1%	1%	3%
Organizations reporting to SEI	156	353	458	541	621	734	901



Source: http://www.sei.cmu.edu/sema/profile.html

Know Thy Competition

Some Organizations at CMM Level 4 or 5

BFL Software
Citicorp Overseas
CSC Civil Group
Future Software
Hughes
Litton PRC
NCR
Oracle
Siemens Info Systems
Telcordia Tech
USAF Tinker AFB
USN NAWC China Lake

Boeing
Cognizant Tech
DCM Tech
HCL Perot Systems
IBM Global Services
Lockheed Martin
Network Systems
Raytheon
Silverline Tech
United Space Alliance
USA CECOM

CG-Smith Software
CSC Defense Group
DSQ Tech
Honeywell
Int. Computers
Motorola
Northrop Grumman
Satyam Computer
Tata Consultancy
USAF Hill AFB
USN FMSO
Wipro GE Med Systems

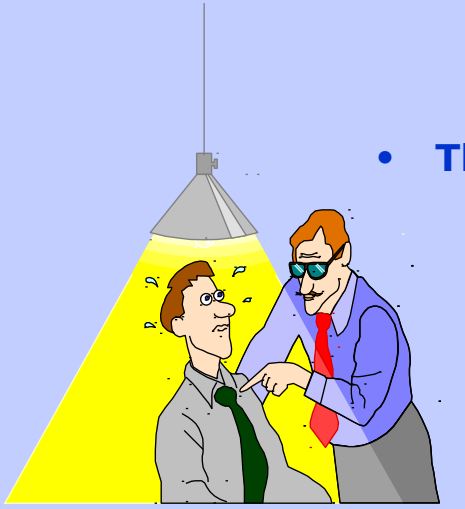
Some CMM Variants

SW-CMM	Capability Maturity Model for Software
T-CMM	Trusted CMM
SSE-CMM	Systems Security Engineering CMM
SE-CMM	Systems Engineering CMM
P-CMM	People CMM
SA-CMM	Software Acquisition CMM
IPD-CMM	Integrated Product Development CMM
FAA-iCMM	FAA's integrated CMM (SW-CMM, SE-CMM, SA-CMM)
CMMI	CMM Integration (SW-CMM, SE-CMM, SA-CMM, IPD-CM

Points to Remember!

- CMM Level 2 focuses on basic management practices of the _____
- CMM Level 3 concentrates on standard software processes of the _____
- Most software organizations today are at CMM Level ____
  - The primary objective of the CMM is

    _____
    - SSC San Diego's ultimate goal is to reach Level ___
  - The CMM was developed by _____



Describing The CMM: Summary

The "Business Case" for using the CMM was addressed in an Air Force Institute of Technology (AFIT) study:

- **The aim was to determine any correlation between the CMM rating and software development success**
- **Observed improved cost and schedule performance with increased process maturity.**
  - **Less mature organizations were likely to have difficulty adhering to cost and schedule baselines**
  - **More mature organizations were likely to meet cost and schedules**

Conclusion: Validated a statistical correlation between project success and CMM ratings

CrossTalk, September 1995

Benefits of the CMM at SSC San Diego

Some testimonials from Level 3 Project Managers

- We produced more complex builds in less time
- Implementing Peer Reviews and other process improvements significantly reduced the problems found and the testing efforts (e.g., reduced trouble reports by 71%, time to conduct tests by 33%, time to fix all trouble reports by 70%)
- The project people have told me they would not work on another project without defined processes
- I travel a lot and having defined processes makes turnover completely seamless between me and my acting
- We are now consistently producing builds with zero defects
- We have better communication across the team, and people know what they are supposed to be doing
- I feel I am a much better project manager
- We have fewer surprises, last minute glitches, and fire drills
- We have fewer risks this year because we learned from our Risk Management Plan from last year
- We have been awarded new work based on our SPI efforts

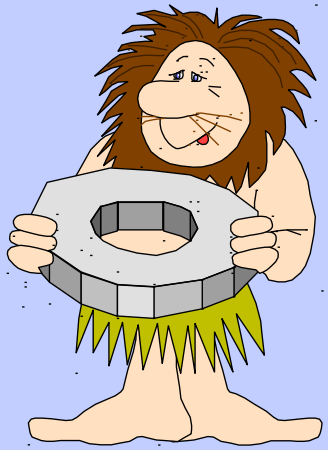
CMM References

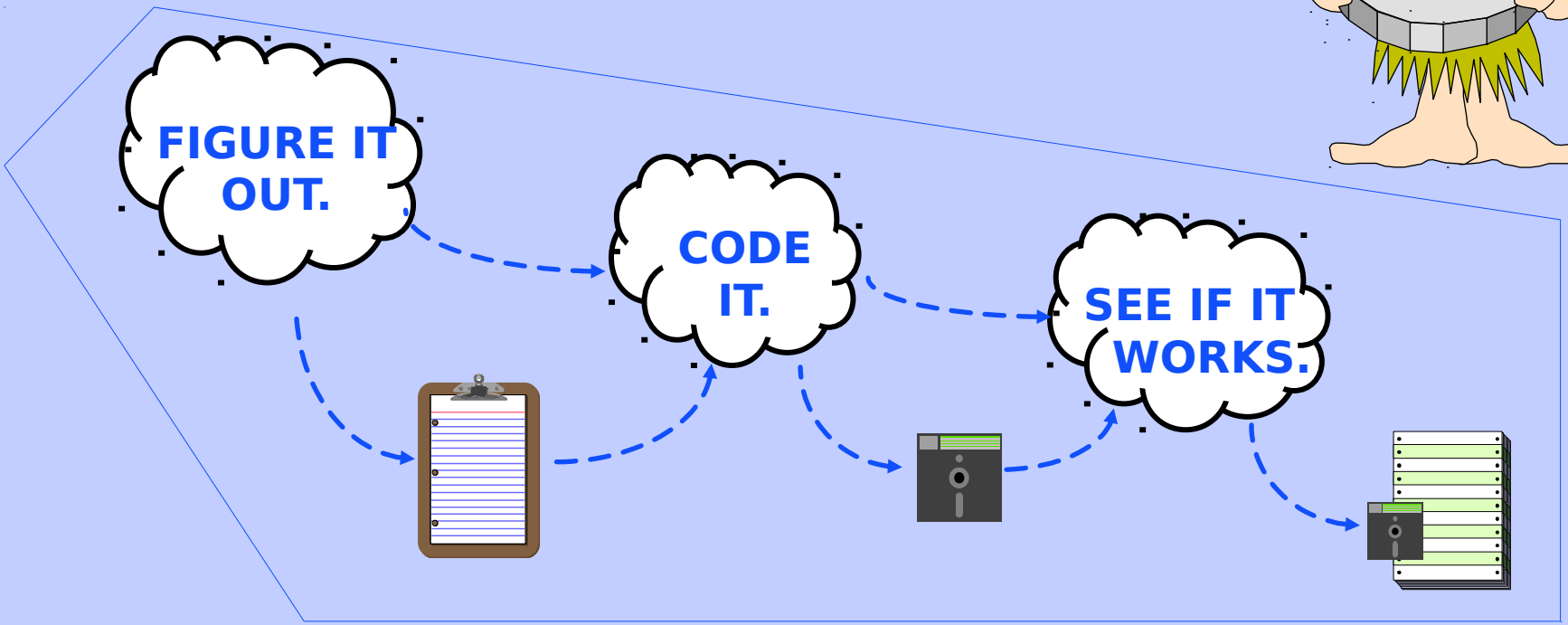
- Capability Maturity Model (CMM) for Software, Version 1.1. CMU/SEI-93-TR-24 & 25 , February 1993
  - http://sepo.spawar.navy.mil/sepo/CMMinfo.html
- Benefits of CMM-Based Software Process Improvement: Initial Results. CMU/SEI-94-TR-13, August 1994
  - http://www.sei.cmu.edu/publications/documents/94.reports/94.tr.013.html
- A Software Process Framework for the SEI CMM, Handbook. CMU/SEI-94-HB-01, September 1994
  - http://www.sei.cmu.edu/publications/documents/94.reports/94.hb.001.html
- Article: The C*apability Maturity Model for Software.* Mark C. Paulk, Bill Curtis, Mary Beth Chrissis, Charles V. Weber. *(in Section 7 of SME Guidebook)*
  - http://www.sei.cmu.edu/publications/documents/96.reports/96.ar.cmm.v1.1.html
- SEI CMM Level 5: For the Right Reasons. George Yamamura and Gary Wigle, Boeing Defense & Space Group. CrossTalk, August 1997.
  - http://www.stsc.hill.af.mil/CrossTalk/1997/aug/seicmm5.html
- SEPO's Power Point presentation on "The Capability Maturity Model: an Overview" http://sepo.spawar.navy.mil/sepo/CMMinfo.html
- Key Process Area flow charts, at http://sepo.spawar.navy.mil/sepo/CMMinfo.html

Backup CMM Material

- Key Process Areas of each Maturity Level
- Level 1 Processes and results
- Goals, Artifacts, and Training requirements of each KPA at Levels 2, 3, 4, 5

The Level 1 Process - The Insider's View

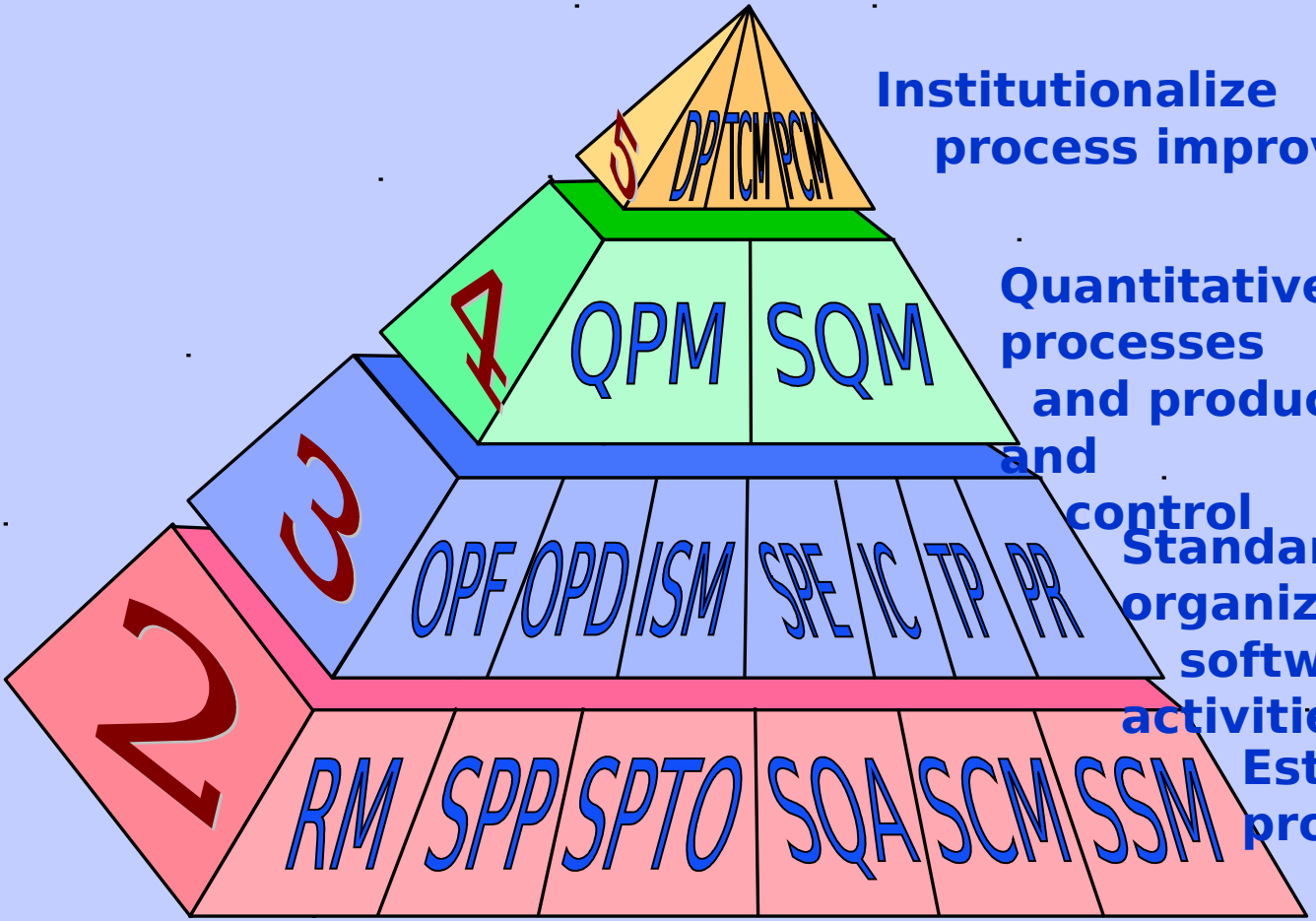




Common Results Produced by Immature Organizations

PARAMETER	RESULT
Requirements	Poorly controlled, requirements "creep"
Product performance	Unpredictable, doesn't meet user needs
Product configuration	Not managed
Product Quality	Unknown, defect ridden
Costs	Poorly tracked, often overrun
Schedule	Frequently late

CMM Building Blocks: the KPAs



Institutionalize process improvement

Quantitative analysis of processes and products for monitoring and control

Standardize the organization's software process activities

Establish basic project management controls

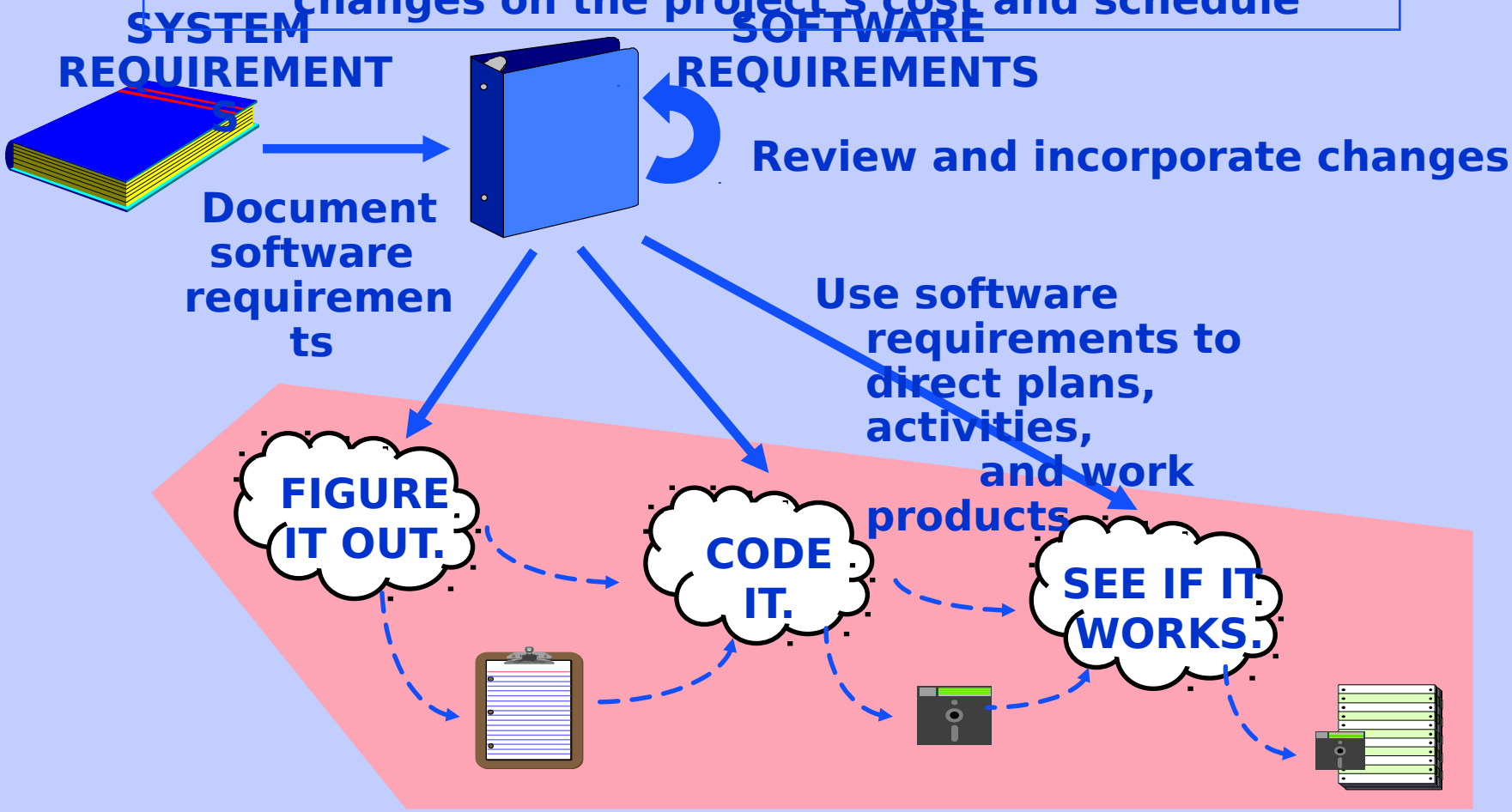
CMM Level 2 Key Process Areas and Purposes

"Repeatable Level" - 6 KPAs

KPA	Purpose
• Requirements Management	To establish a common understanding of requirements among the customer and all development groups
• Software Project Planning	To establish complete and reasonable project plans
• Software Project Tracking and Oversight	To provide visibility into actual progress to enable timely corrective action
• Software Quality Assurance	To provide management with visibility into the process and products; defends and reinforces a process culture
• Software Configuration Management	To establish and maintain the integrity of the software products throughout the life cycle
• Software Subcontractor Management	To support selection of qualified subcontractors and effective management of their

Applying Requirements Management (RM)

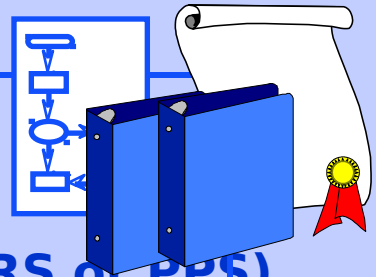
Purpose: To establish understanding of requirements among all parties; stabilize software requirements and clarify the impact of changes on the project's cost and schedule



RM KPA Goals, Artifacts, Training

Goals

- Software requirements are baselined
- Software plans, products, and activities are kept consistent with the software requirements



Example Artifacts

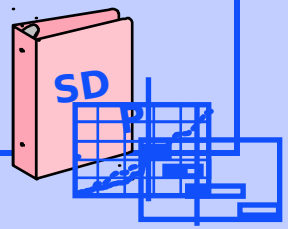
Organization RM Policy

Baselined software requirements document (SRS or PPS)

Documented changes (ECPs), trouble reports (STRs)

Change implementation process

Project schedules and plans

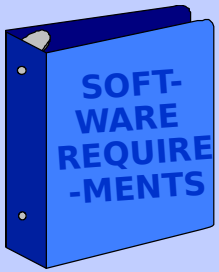


Training Requirements

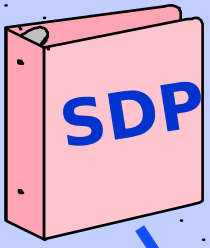
- Software engineering groups are trained to perform their requirements management activities.

Applying Software Project Planning (SPP)

Purpose: To establish complete and reasonable project plans; improve cost and schedule estimates and document the project activities



Document the Software Development Plan

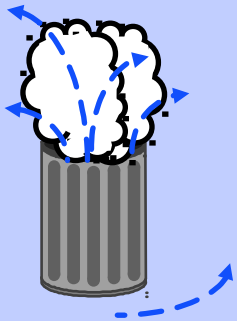


Estimate size, cost, effort

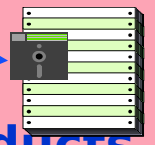
Schedule the activities

Define the software life cycle

DESIGN → CODE → TEST



(Get rid of those fuzzy processes)



Identify software work products

SPP KPA Goals, Artifacts, Training

Goals

- Software estimates are documented for planning and tracking
- Software project activities and commitments are planned and documented
- Affected groups agree to their project commitments

Example Artifacts

Organization SPP Policy and Process

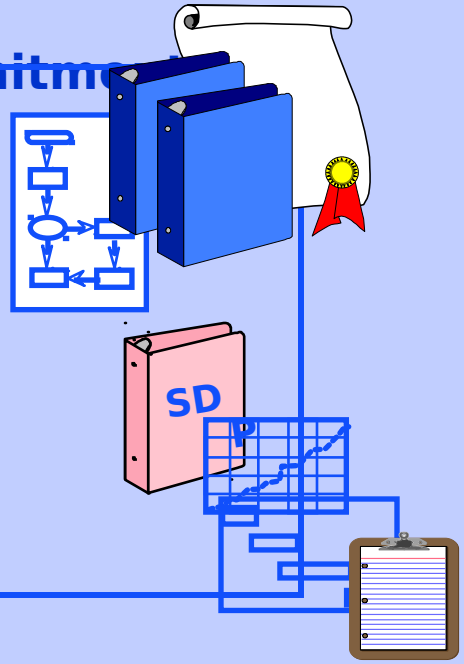
Software development plan and risks

Planning and Estimation processes

Work authorizations, tasking statements

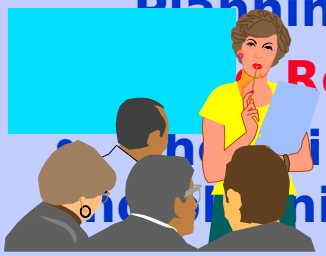
Work schedules

Planning meeting minutes



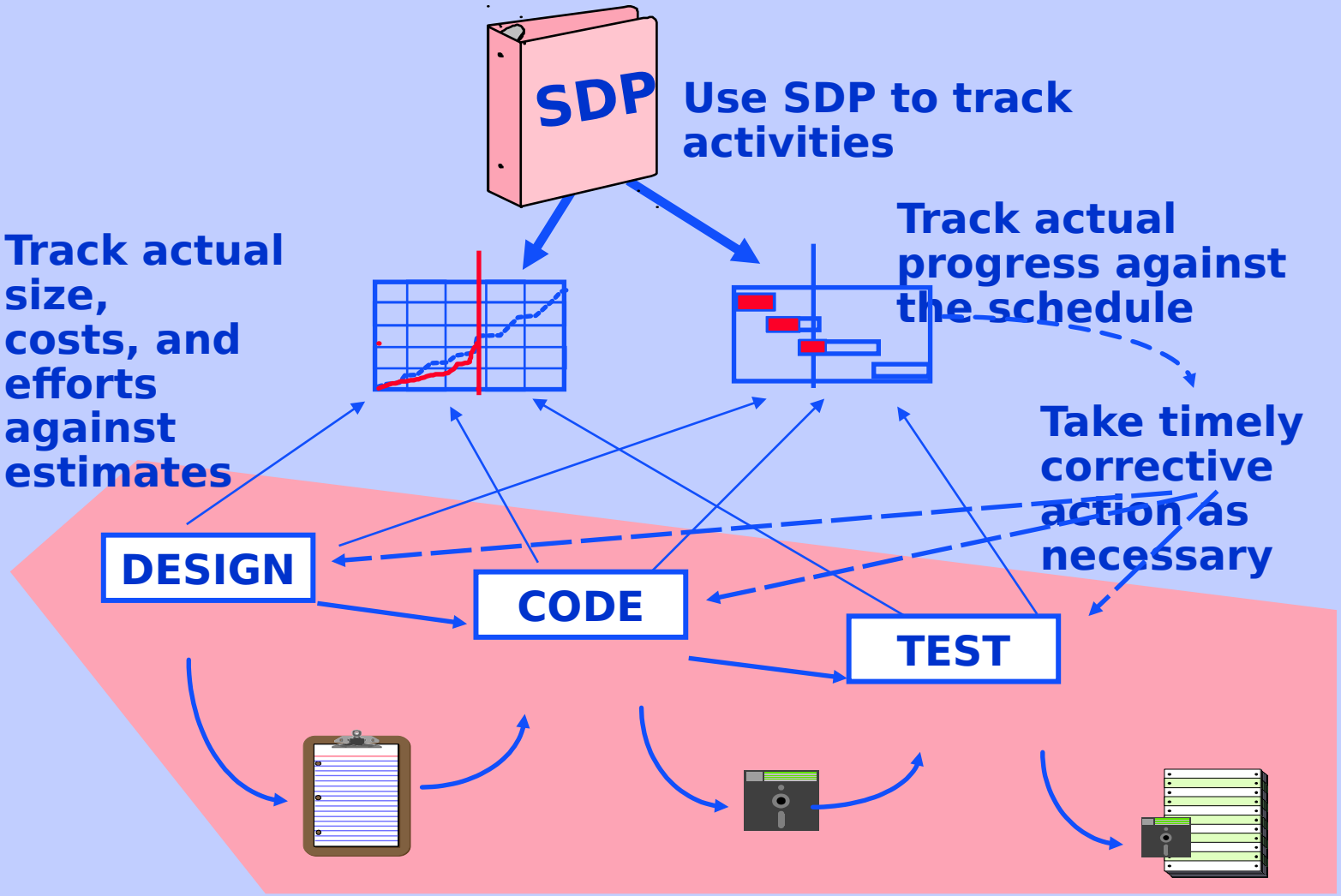
Requirements

involved in planning are trained in estimating
ning



Applying Software Project Tracking & Oversight (SPTO)

Purpose: To provide visibility into actual progress and oversight to enable timely corrective action



SPTO KPA Goals, Artifacts, Training

Goals

- Actual results are tracked against plans
- Corrective action is taken when actuals deviate significantly
- Changes to commitments are agreed to by all affected groups

Example Artifacts

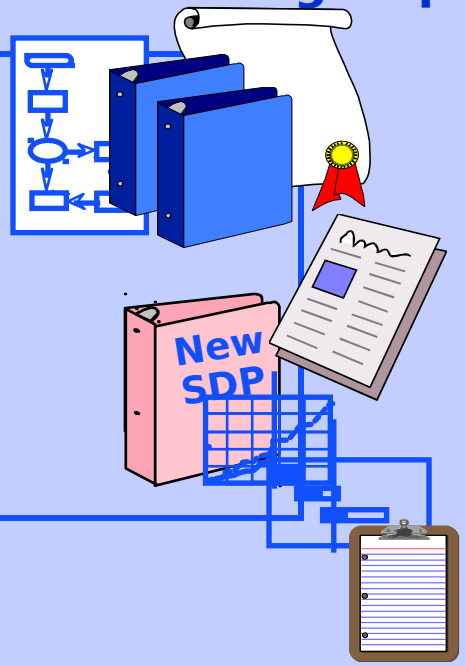
Organization SPTO policy

Organization and Project SPTO process

Status and metrics reports

Plan and schedule revisions

Replanning data



Requirements

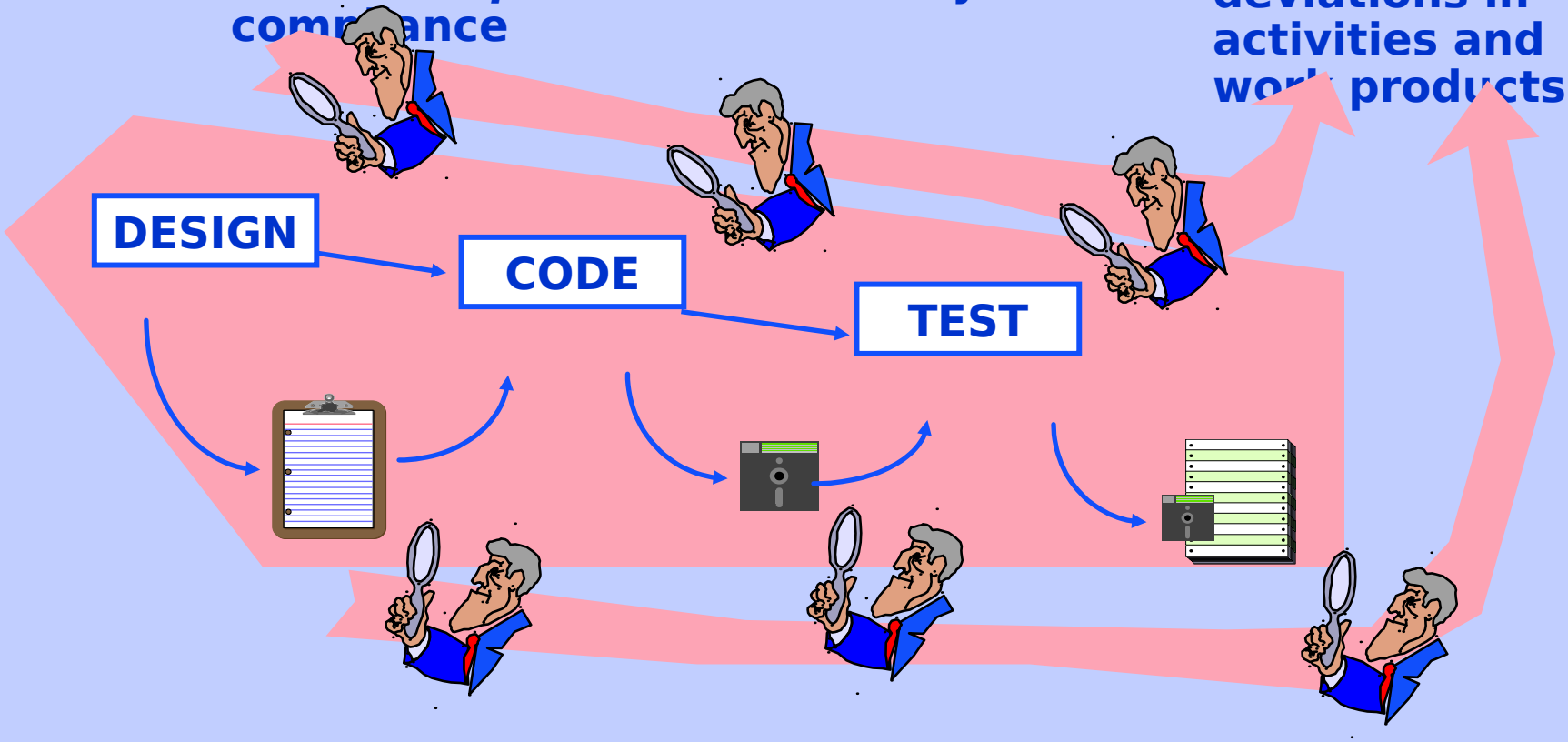
ers and supervisors are trained in managing the project's technical aspects

Applying Software Quality Assurance (SQA)

Purpose: To provide management with objective visibility into the software process and the products being built

Review software engineering activities (*processes*) to verify compliance

Identify deviations in activities and work products

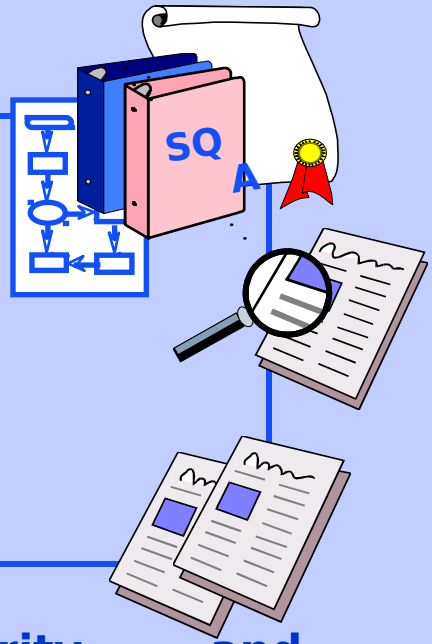


Audit work *products* for compliance

SQA KPA Goals, Artifacts, Training

Goals

- SQA activities are planned
- Products and activities are verified against requirements
- SQA results are publicized
- Noncompliance issues are addressed



Example Artifacts

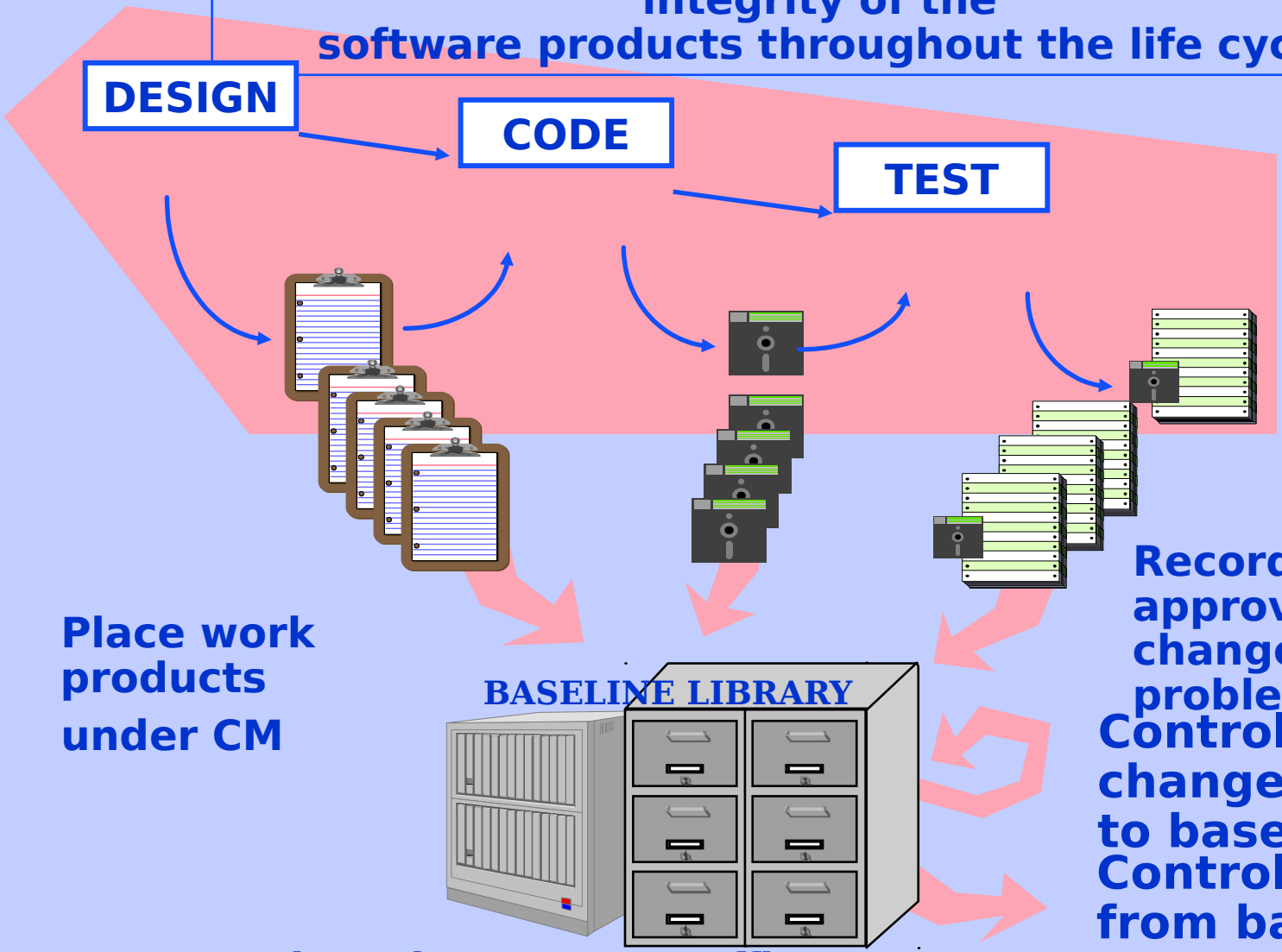
- Organization SQA policy
- Organization and Project SQA process
- SQA Plan
- SQA reports and action items
- Software development files

Training Requirements

- SQA group is trained in their activities
- ct members are oriented on roles, authority, and
  QA group

Applying Software Configuration Management (SCM)

Purpose: To establish and maintain the integrity of the software products throughout the life cycle



Place work products under CM

Record, review, approve, and track changes and problems

Control changes to baselines

Control releases from baselines

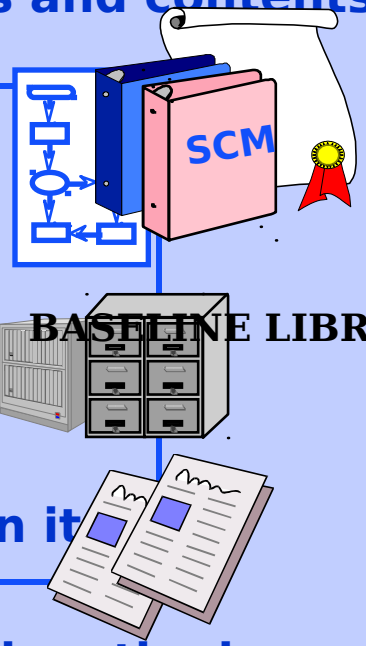
SCM KPA Goals, Artifacts, Training

Goals

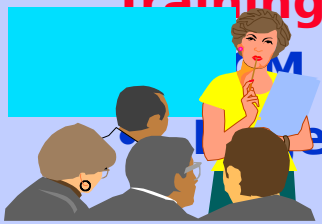
- SCM activities are planned
- Software products are identified, controlled, and available
- Changes are controlled
- Affected groups are informed of baseline status and contents

Example Artifacts

- Organization SCM policy
- Organization and Project SCM process
- CM procedures and SCM Plan
- Configuration Status Accounting Reports
- Baselined work products
- Configuration Control Board reports and action it



Training Requirements

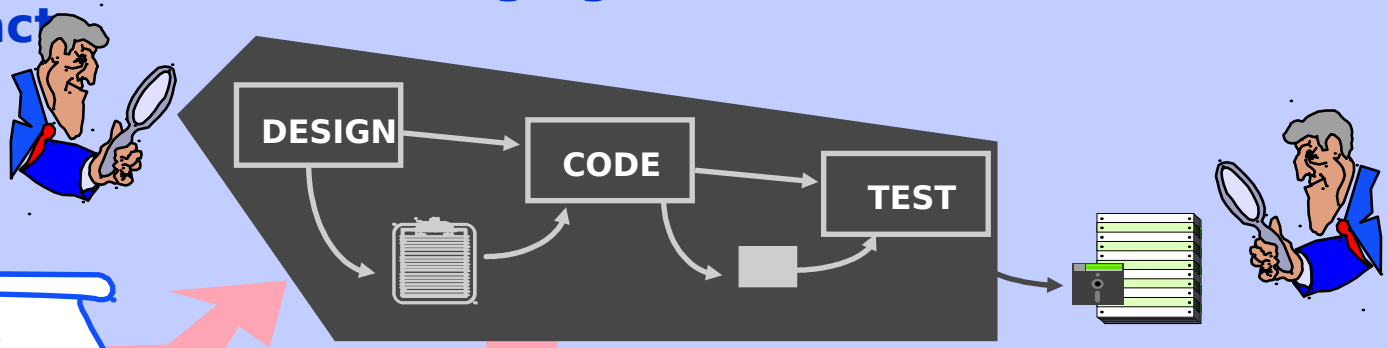


- M group is trained in their procedures and methods
- ect members are trained to perform their SCM activities

Applying Software Subcontract Management (SSM)

Purpose: To support selection of qualified subcontractors and effective management of their activities

Designate COR for managing contract



Define Statement of Work; select qualified contractor

Approve contractor's SDP to track activities

Review contractor's accomplishments and products

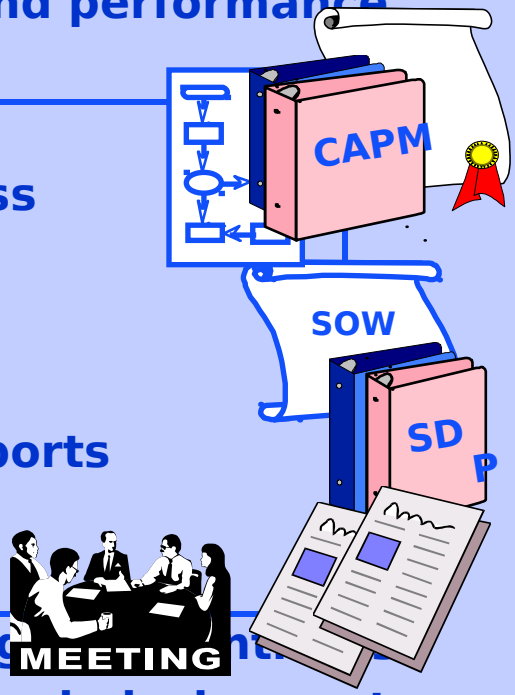
SSM KPA Goals, Artifacts, Training

Goals

- Qualified subs are selected
- The prime and sub agree to commitments to each other
- Communications are maintained
- The prime tracks the sub's actual results and performance

Example Artifacts

Organization SCM policy and CAPM process
Subcontract; SOW
Guidelines for selecting subs
Sub's plans: SDP, SQA, PMP
Sub's progress reports, SQA, and SCM reports
Technical meeting minutes



Training Requirements

- Software managers are trained to manag
- ware managers are oriented in the technical aspects
  e subcontract

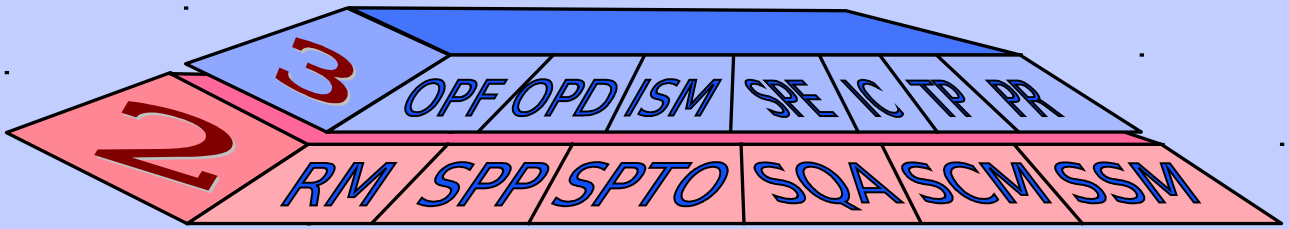
The CMM's Approach to Potential Project Weaknesses

Is this your problem?	Applicable Level 2 KPA
Requirements unclear, change frequently	____
Poor/no estimates of cost and schedules	____
Little insight into progress and status	____
Few checks on product and process quality	____
Little control over product baselines	____
Unqualified contractors, no contract controls	____

CMM Level 3 Key Process Areas and Purposes

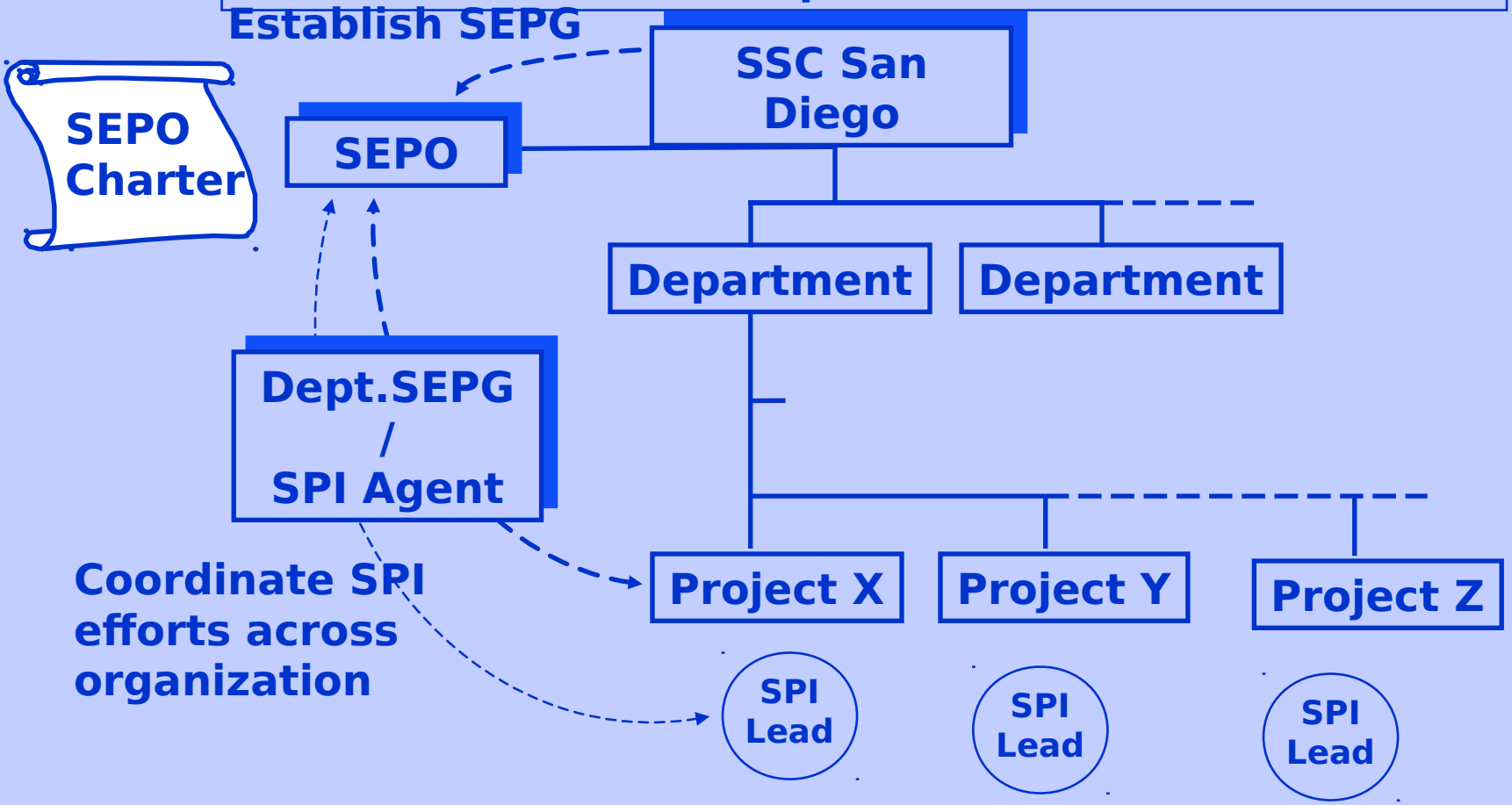
"Defined Level" - 7 KPAs

KPA	Purpose
• Organization Process Focus	Assign organization's SPI coordinator
• Organization Process Definition	Develop organizational best practices and project data repository
• Integrated Software Management	Tailor organizational best practices to projects
• Software Product Engineering	Set development standards
• Intergroup Coordination	Promote teamwork among all groups
• Training Program	Develop practitioner skills
• Peer Reviews	Remove defects from work products



Applying Organization Process Focus (OPF)

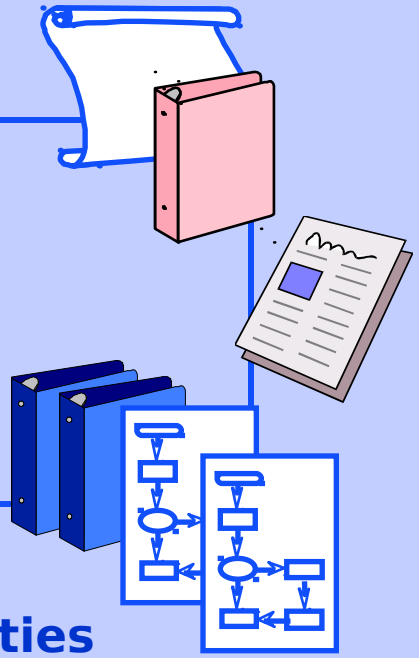
Purpose: To establish the organizational responsibility for software process activities that improve the organization's overall software process



OPF KPA Goals, Artifacts, Training

Goals

- Software process development and improvement is coordinated
- Process strengths and weaknesses are identified
- Organization-level SPI activities are planned



Example Artifacts

- SEPO charter
- SPI goals and plan
- SCE results
- Process standards

Training Requirements

- SPI group is trained to perform their activities
- ware groups are oriented in org's process activities
- eir roles in those activities

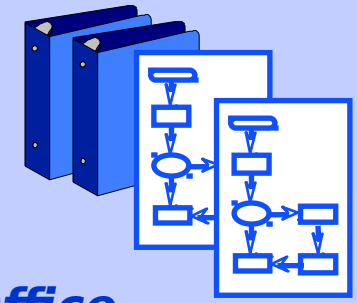
Applying Organization Process Definition (OPD)

Purpose: To develop and maintain a usable set of software process assets that improve process performance across the projects and provide a basis for cumulative, long-term benefits to the organization.

PROCESS ASSET LIBRARY

ORGANIZATION'S PROCESS ASSETS
KPA Policies, Processes, Training courses, Approved life cycle strategies, Project Plan Templates, Tailoring guidelines, Sample/Proje Procedures, process database

Information Exchange



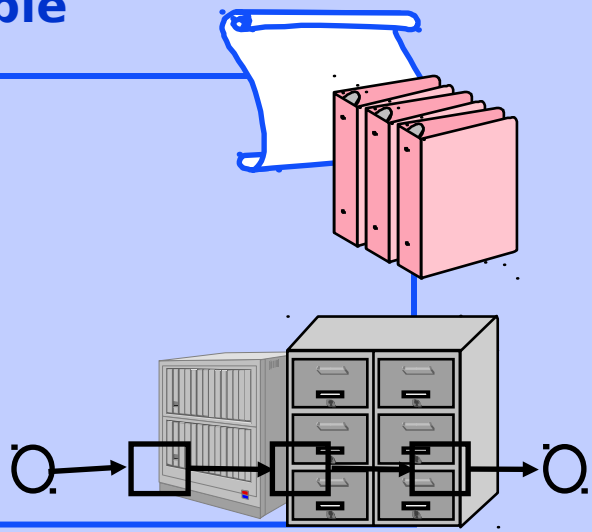
Project Plans, Processes, Procedures, Best Practic

Projects

OPD KPA Goals, Artifacts, Training

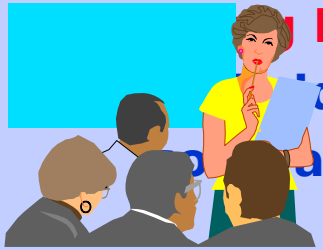
Goals

- A standard software process for the organization is developed and maintained
- Info on the use of the organization's standard software process is collected, reviewed, and made available



Example Artifacts

- Organization OPD policy
- Organization process standards
- SSC Process Asset Library (PAL)
- Project Data Repository
- Department PALs



Requirements

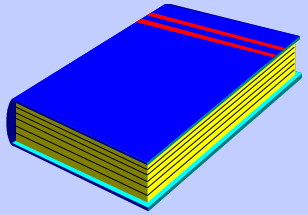
- duals who develop and maintain the org's standard
- are process receive training to perform these activities

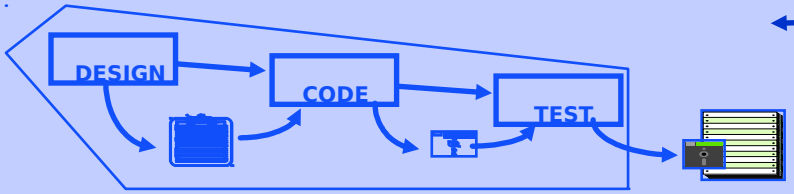
Applying Integrated Software Management (ISM)

Purpose: To integrate the software engineering and management activities into a coherent, defined software process tailored from OPD.

SSC San Diego Standard Software Process (best practices)

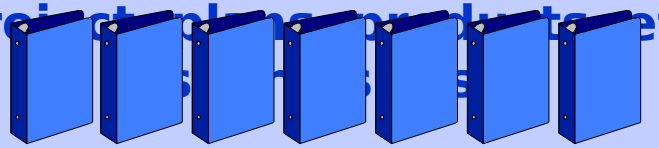
Apply Tailoring and Estimating Guidelines





Establish the Project's Plan and develop Defined Software Process (best practices)

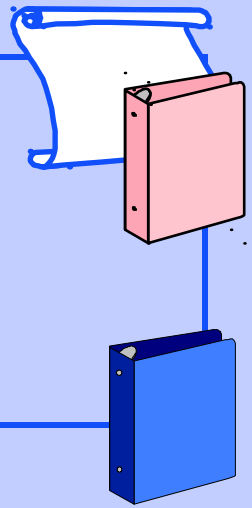
Use documented procedures to plan and manage the project's plans, products, efforts, [illegible]



ISM KPA Goals, Artifacts, Training

Goals

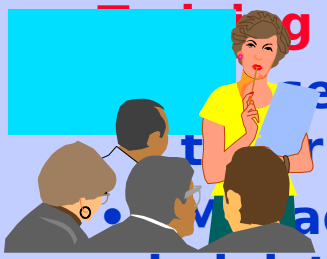
- The project's defined software process is tailored from the organization's standard software process
- The project is planned and managed based on the project's defined defined process



Example Artifacts

Organization ISM policy

Procedures for planning, tracking, managing

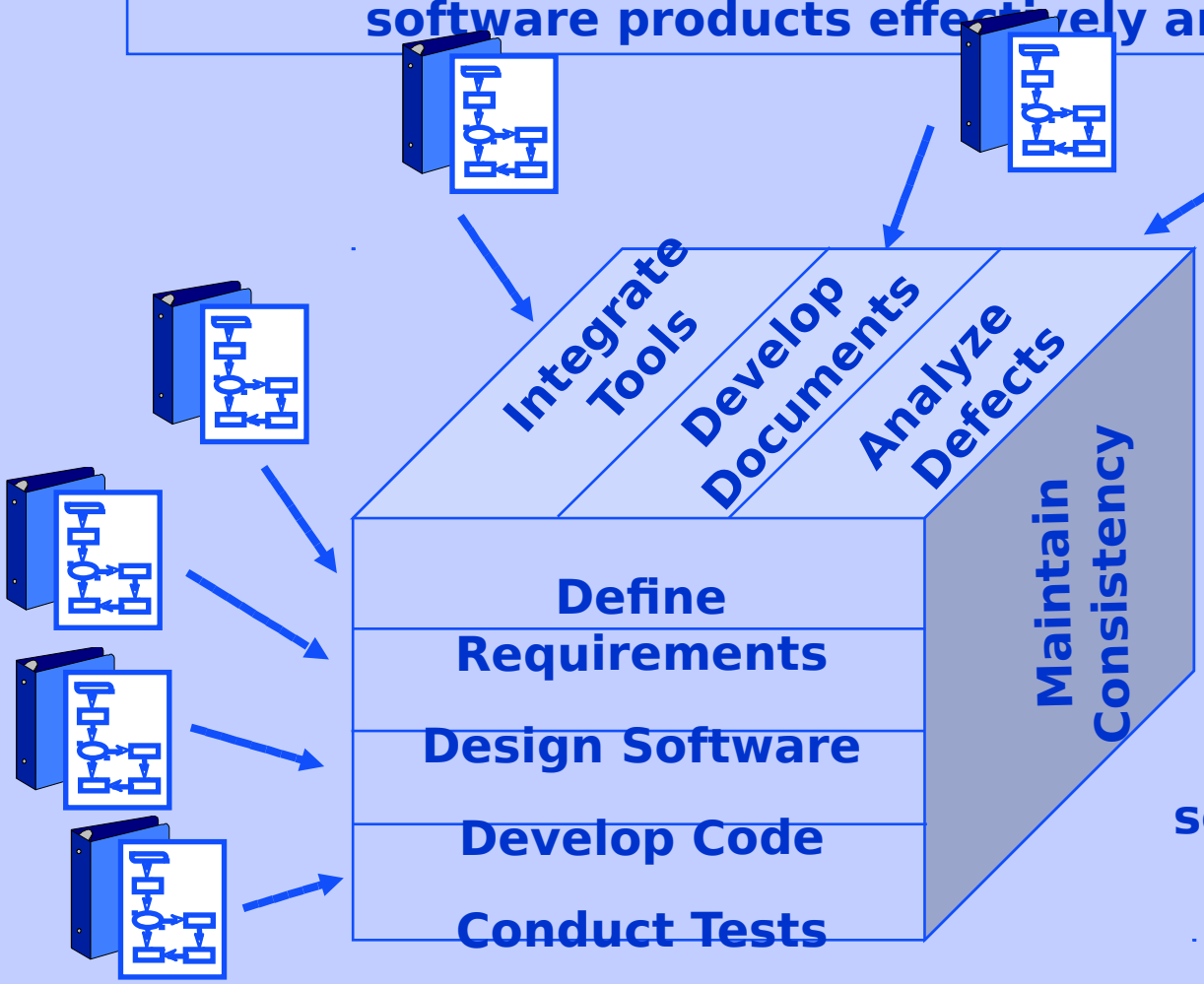


Training Requirements

- Those who develop the project's process receive training in tailoring the org's process and use related process assets
- Managers are trained in managing technical, administration, and personnel aspects

Applying Software Product Engineering (SPE)

Purpose: To consistently perform a well-defined engineering process that integrates all the software engineering activities to produce correct, consistent software products effectively and efficiently.



Define and perform all software engineering tasks based on a defined process

SPE KPA Goals, Artifacts, Training

Goals

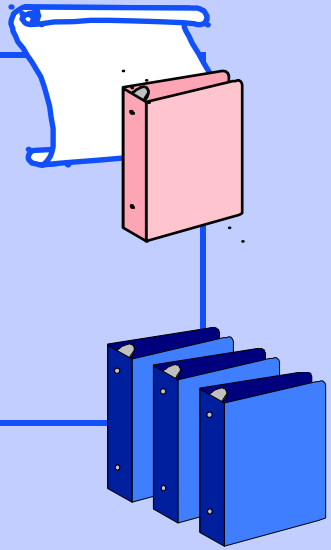
- Software eng'r tasks are defined, integrated, and consistently performed
- Software work products are kept consistent with each other

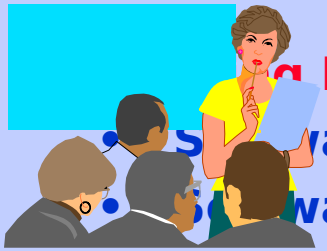
Example Artifacts

Organization SPE policy

Project's defined process for design, coding, testing, documenting, etc.

Standards used





g Requirements

- S ware engineers are trained for their technical jobs
- S ware engineers are oriented in related software eng'rg
- Managers are oriented in the project's technical aspects

Applying Intergroup Coordination (IC)

Purpose: To establish a means for the software engineering group to participate actively with the other engineering groups so the project is better able to satisfy the customer's needs effectively and efficiently.

Customer

All affected groups agree to customer requirements

Software Engineering Group

All groups agree to commitments

Identify/Resolve/Track Intergroup Issues

Affected Groups: Users, Testers, QA, etc.

IC KPA Goals, Artifacts, Training

Goals

- The customer's requirements are agreed to by all affected groups
- The commitment between groups are agreed to by the affected groups
- The engineering groups identify, track, and resolve inter-group issues

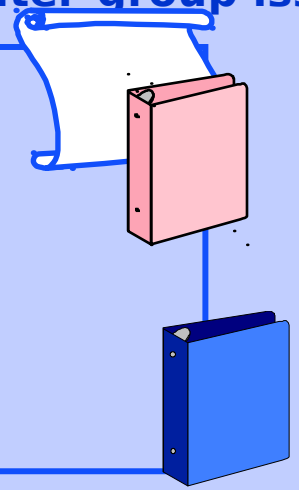
Example Artifacts

Organization IC policy

Integrated project schedules

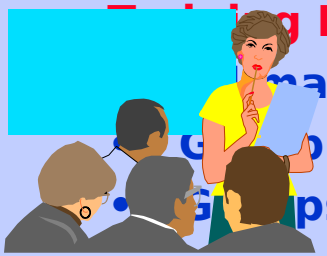
Meeting minutes and action items

Cross-functional team meetings, working groups, and databases



Training Requirements

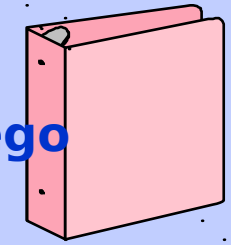
- Managers receive required training in teamwork
- Group leaders are oriented in the processes of other groups
- Groups receive orientation in working as a team

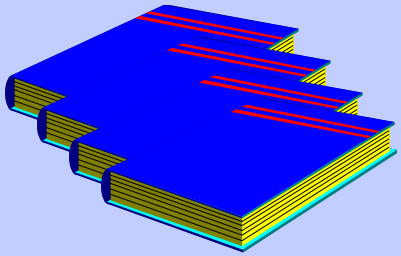


Applying the Training Program (TP)

Purpose: To develop the skills and knowledge of individuals so they can perform their roles effectively and efficiently.

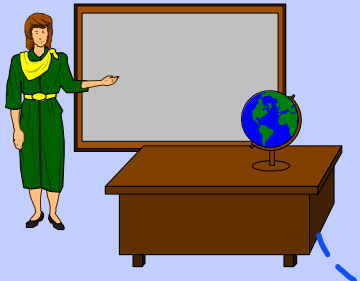
Establish SSC San Diego Training Plan





Establish Project Training Plans

Conduct Training Courses



Trained Project Personnel

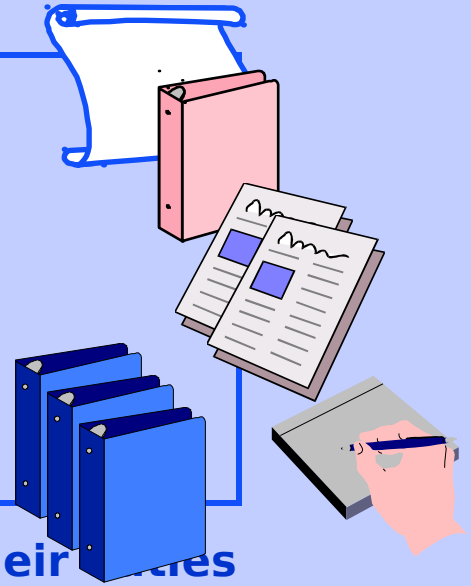
TP KPA Goals, Artifacts, Training

Goals

- Training activities are planned
- Training for software management and technical roles is provided
- Software groups receive the training to perform their roles

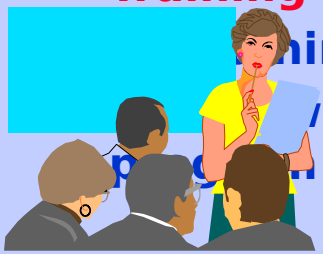
Example Artifacts

Organization TP policy and process
Training requirements by position
Training plan and schedule
Training curriculum
Training attendance records



Training Requirements

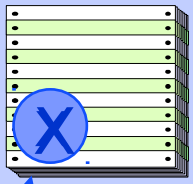
ning group has skills and knowledge for their ties
vare managers receive orientation on the training
p



Applying Peer Review (PR)

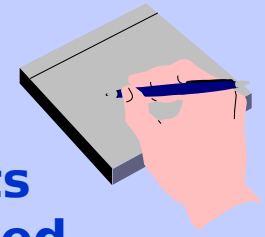
Purpose: To remove defects from the software work products early and efficiently. Also develop a better understanding of the software work products and of defects that might be prevented.

Work Product



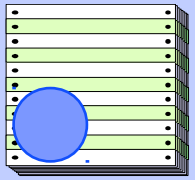
Defect

Inspection Team conducts Peer Review



Defects recorded, tracked to closure

Work Product 1.1

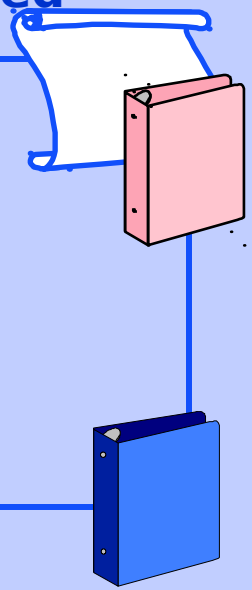


Defect eliminated

PR KPA Goals, Artifacts, Training

Goals

- Peer review activities are planned
- Work product defects are identified and removed



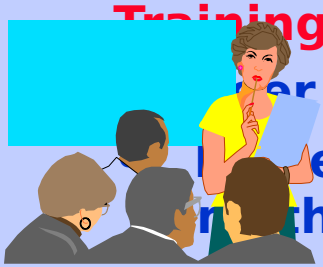
Example Artifacts

Organization PR policy, process

Project plan for PRs of products

PR meeting minutes, defect logs

Training Requirements

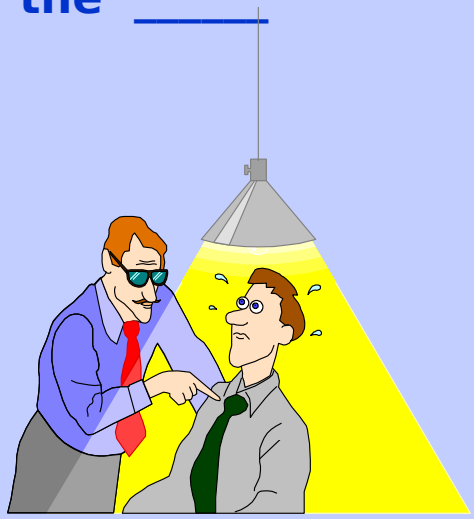


r review leaders receive training in leading peer reviews

ewers receive training in the objectives, principles, and
thods of peer reviews

Points to Remember about Level 3!

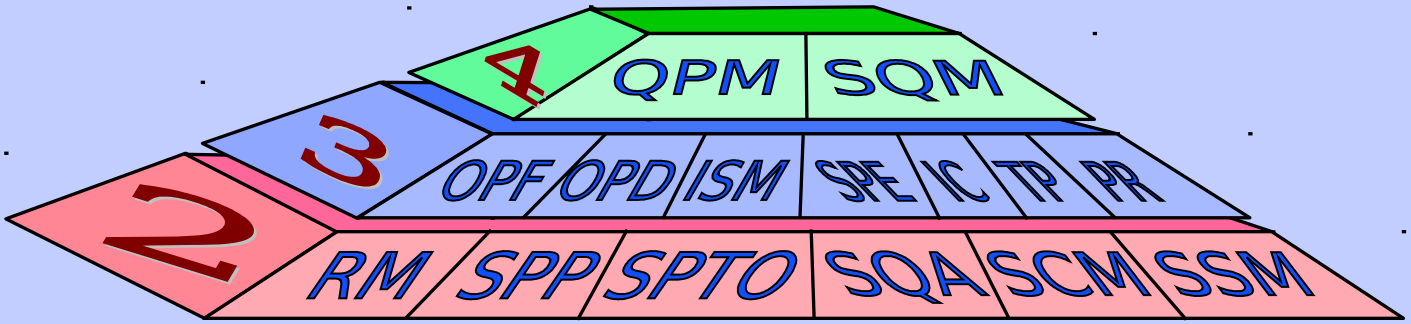
- The group that coordinates an organization's SPI efforts is called _____
- The organization's best practices, templates, process data, and guidelines are available in _____
- Processes describing the life cycle phases of design, code, and test are addressed by the _____ KPA.
- Ensuring that team members have the proper skills and knowledge to perform their jobs is the concern of the _____ KPA.
- Identifying and removing defects from software work products is the purpose of the _____ KPA.



CMM Level 4 Key Process Areas and Purposes

"Managed Level" - 2 KPAs

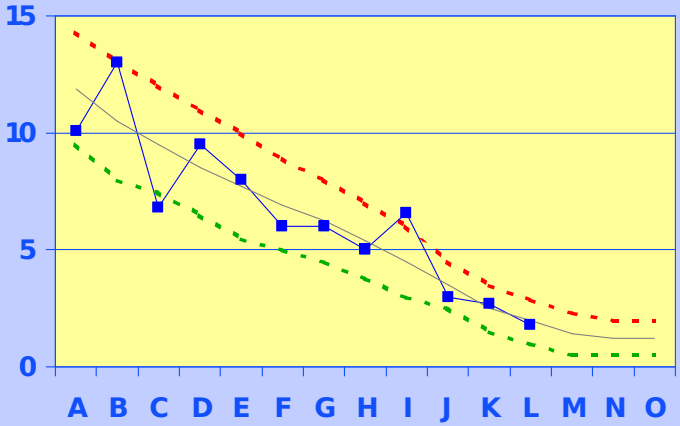
KPA	Purpose
• Quantitative Process performance Management	To control the *process* of the software project quantitatively
• Software Quality Management	To develop a quantitative understanding of the quality of the project's software quality *products* and achieve specific goals



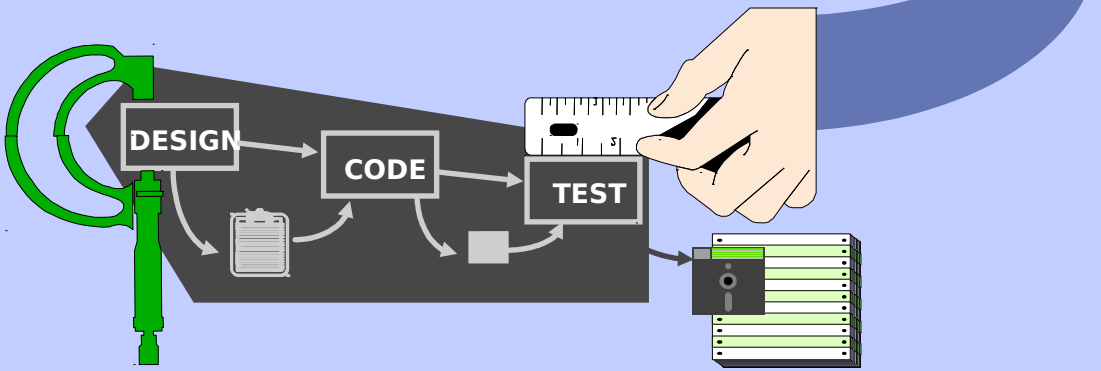
Applying Quantitative Process Management (QPM)

Purpose: To control the process performance of the software project quantitatively.

Set goals for process performance ***(e.g., effort, cycle time, defect removal efficiency)***



Measure process performanc e against goals



Establish process capability baseline; adjust processes

QPM KPA Goals, Artifacts, Training

Goals

- QPM activities are planned
- Process performance of the project's process is controlled quantitatively
- Process capability of the org's standard software process is quantified

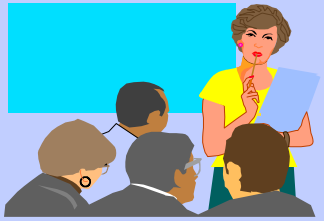
Example Artifacts

Organization QPM policy

Project QPM Plan and strategy

Quantitative measurement data

Process capability baseline



Training Requirements

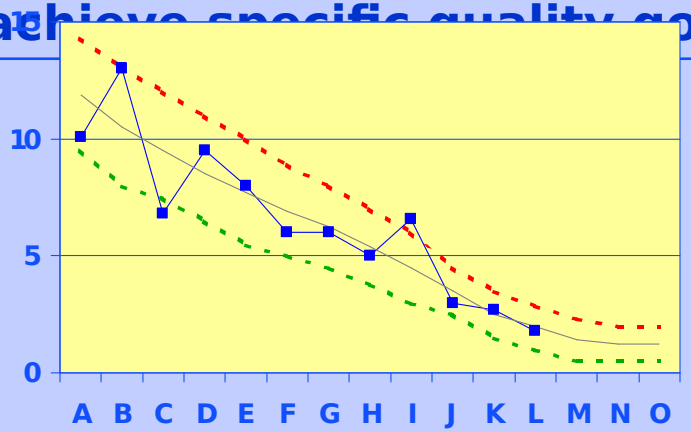
- Individuals involved in QPM receive training

Applying Software Quality Management (SQM)

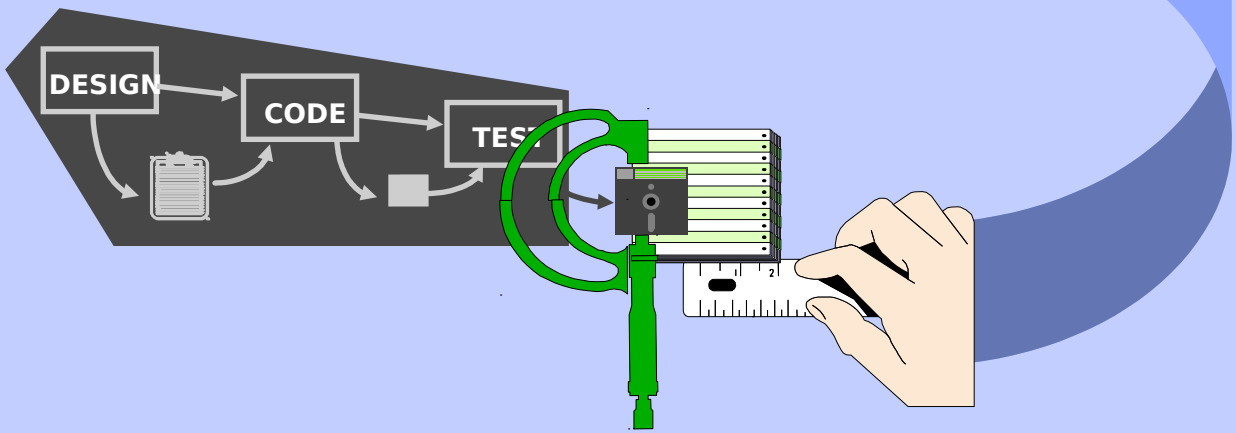
Purpose: To develop a quantitative understanding

of the quality of the project's software products and achieve specific quality goals

Set goals for product quality ***(e.g., reliability, defect density)***



Measure product quality against goals



Adjust plans, products, activities to satisfy customer's needs

SQM KPA Goals, Artifacts, Training

Goals

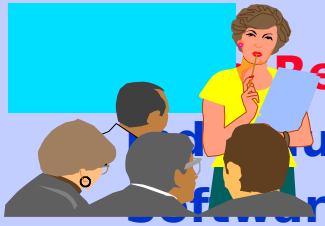
- Projects SQM activities are planned
- Measurable goals for product quality and their priorities are defined
- Progress toward achieving quality goals is quantified and managed

Example Artifacts

Organization SQM Policy

Project Software Quality Plan and goals

Measurements of product quality against goals



Requirements

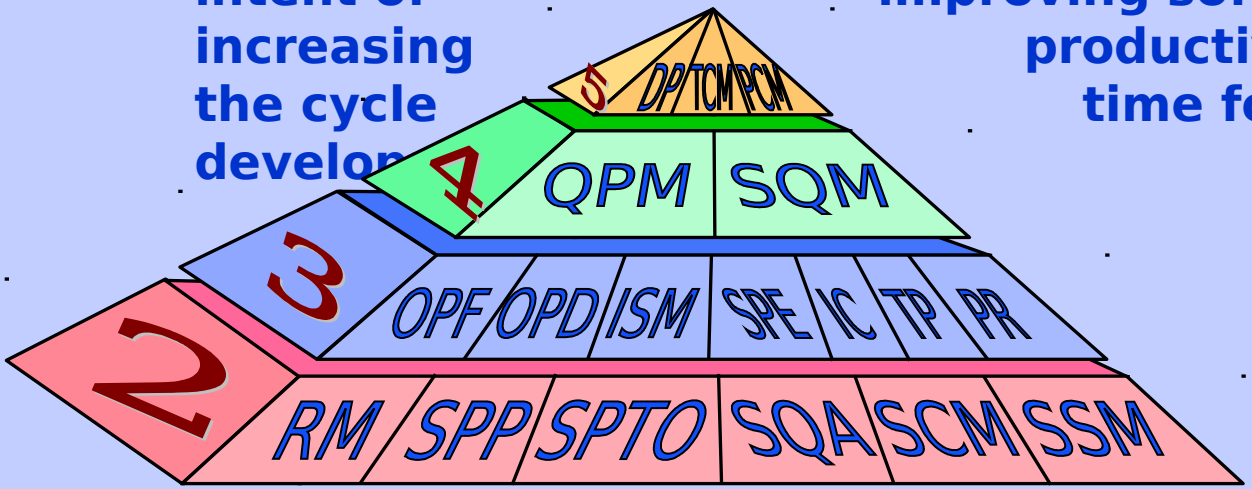
Individuals implementing SQM receive training

Software engineers receive training in SQM

CMM Level 5 Key Process Areas and Purposes

"Optimizing Level" - 3 KPAs

KPA	Purpose
• Defect Prevention	To identify the cause of defects and prevent them from recurring
• Technology Change Management	To identify new technologies (I.e., tools, methods, and processes) and transition them into the organization
• Process Change processes Management	To continually improve the software used in the organization with the intent of improving software quality, increasing productivity, and decreasing the cycle time for product develop



Applying Defect Prevention (DP)

Purpose: To identify the cause of defects and prevent them from recurring

Analyze defects encountered

Take action to prevent recurrence

Promulgate lessons learned

DP KPA Goals, Artifacts, Training

Goals

- DP activities are planned
- Common causes of defects are sought out and identified
- Common causes of defects are prioritized and systematically eliminated

Example Artifacts

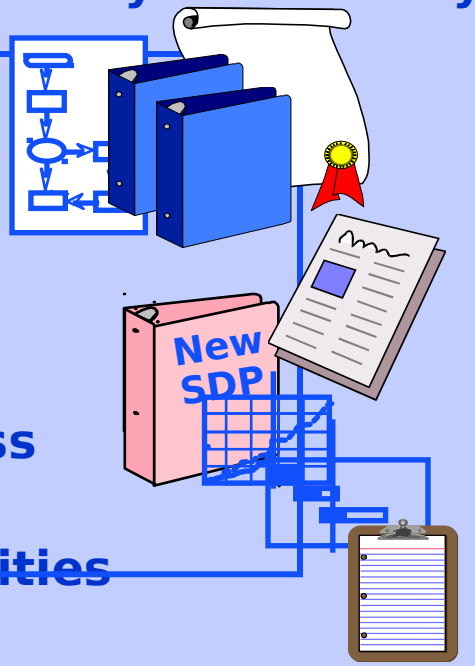
Organization DP Policy

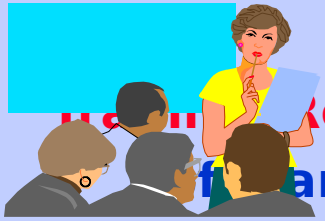
DP plans, teams

DP data documented and tracked

Revisions to OSSP, project's defined process from DP actions

Feedback on status and results of DP activities





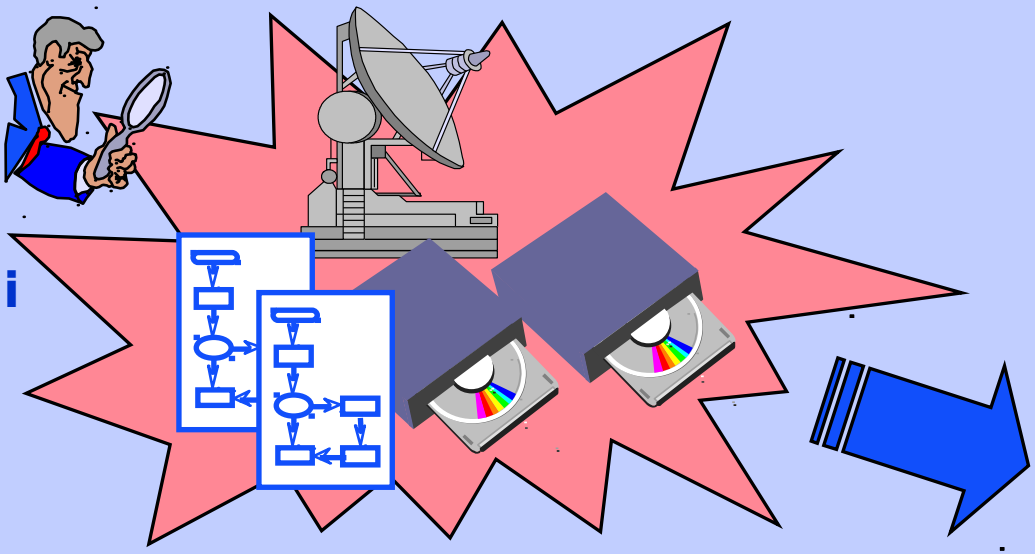
Training Requirements

- Software engineers receive training for DP activities

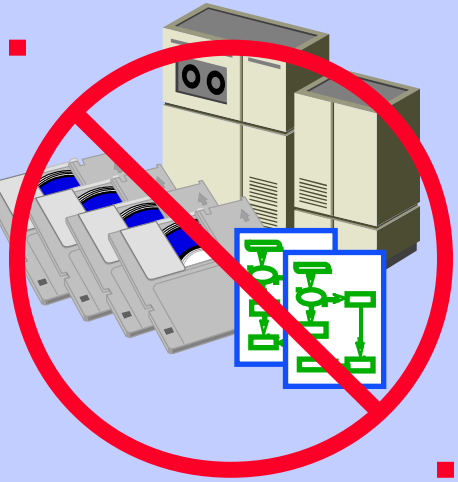
Applying Technology Change Management (TCM)

Purpose: To identify new technologies (i.e., tools, methods, and processes) and transition them into the organization in an orderly manner.

Evaluate new technologies



Use pilot efforts to assess changes



Incorporate changes into projects and organization standards

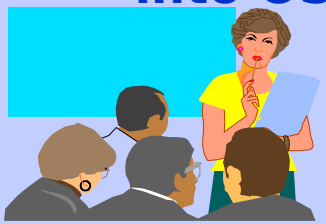
TCM KPA Goals, Artifacts, Training

Goals

- Incorporation of technology changes is planned
- New technologies are evaluated for their effect on quality and productivity
- Appropriate new technologies are transferred into [illegible]al practice

Example Artifacts

- Organization policy and plan for TCM
- New technologies and changes identified
- Pilot efforts for new technology
- Procedures for incorporating new technologies into OSSP, project's defined process

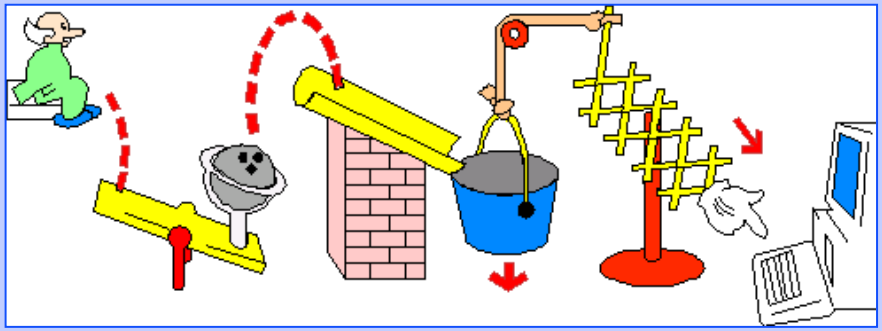


Training Requirements

- Group responsible for TCM receives training

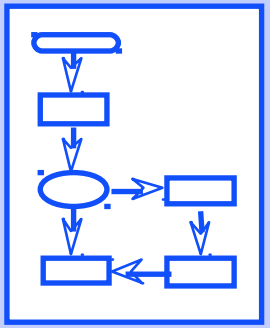
Applying Process Change Management (PCM)

Purpose: To continually improve the software processes used in the organization with the intent of improving software quality, increasing productivity, and decreasing the cycle time for product development.



Identify and evaluate possible improvements

Improve software processes



Train and incentivize staff to make improvements

PCM KPA Goals, Artifacts, Training

Goals

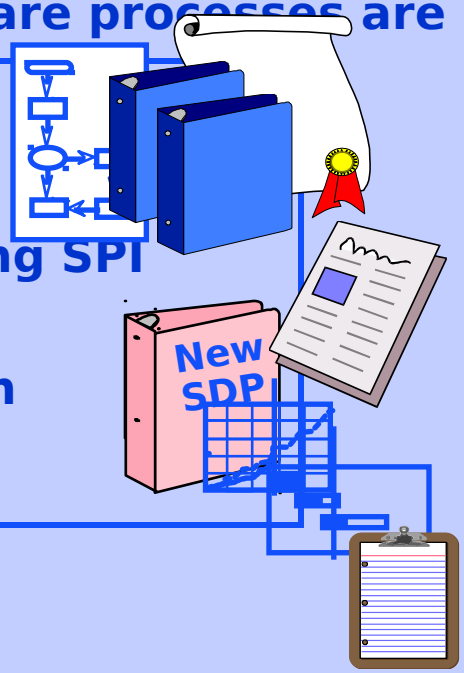
- Continuous process improvement is planned
- Participation in the organization's SPI activities is organization-wide
- The org's SSP and the project's defined software processes are improved continuously

Example Artifacts

Organization policy and plan for implementing SPI

SPI teams formed, improvements piloted

Records and feedback on SPI implementation



Training Requirements

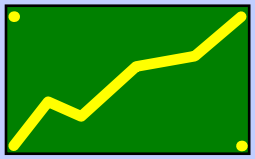
ware managers receive training in SPI

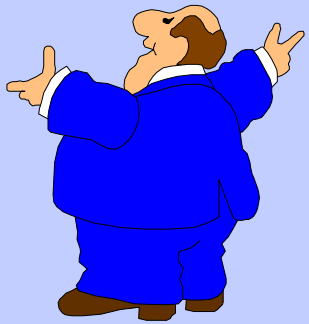
re groups receive training in SPI

managers receive training in SPI

Points to Remember about Levels 4 and 5

- Level 4 focuses on instrumenting both _____ and _____ .
- Finding the root cause of problems is the subject of the _____ KPA.
- The Technology Change Management KPA concentrates on adopting new _____, _____, and _____ .
- The subject of the Process Change Management KPA (and also Level 5, as well as the whole CMM) is _____ .





Do We have to do all this from Scratch?

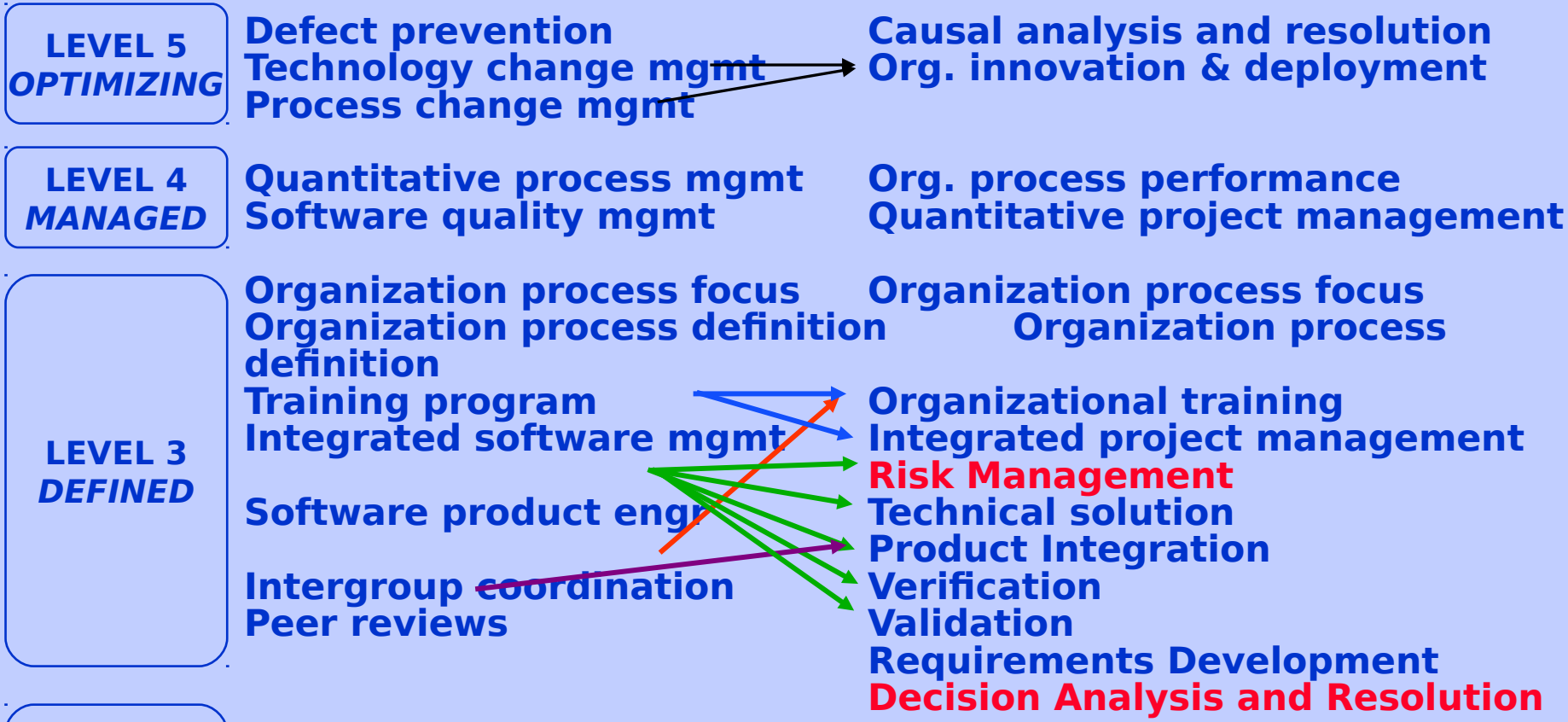
No, because the SSC San Diego Process Asset Library (PAL) contains:

- **Software Engineering Process Policy**
- **Organization's policy for each KPA**
- **Plans, processes and procedures**
- **Guidebooks, handbooks, tailoring guidelines**
- **Templates and forms**
- **Samples and examples**
- **Standards and references**
- **Links to related websites**

Location: http://sepo.spawar.navy.mil/

See: A Description of the SSC San Diego Software Process Assets (SPA) at http://sepo.spawar.navy.mil/sepo/index.html under OPD

Migrating from SW-CMM to the CMMI



Common Feature Comparison

SW-CMM Common Features	CMMI Common Features
Commitment to Perform	Commitment to Perform
Establish an Organizational Policy	Establish an Organizational Policy
Ability to Perform	Ability to Perform
	Plan the Process
Provide Resources	Provide Resources
Assign Responsibility	Assign Responsibility
Train People	Train People
	Directing Implementation
	Manage Configurations
	Monitor and Control the Process
Activities Performed	Activities Performed
Plan the Process	
Perform the Process	Perform the Process
Monitor and Control the Process	
Measurement & Analysis	**Handled by the Measurement and Analysis PA**
Measurement the Process	
Analyze the Measurements	
Verifying Implementation	Verifying Implementation
Review with Org. Management	Review with Management
Review with Project Management	
Objectively Verify Adherence	Objectively Verify Adherence